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AUGUST, 1902. VOL. XX. No. 2.

The Geographical Journal

INCLUDING THE PROCEEDINGS OF THE ROYAL GEOGRAPHICAL SOCIETY.

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The
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ON SNOW-WAVES AND SNOW-DRIFTS IN CANADA,*

With Notes on the "Snow-mushrooms" of the Selkirk Mountains.

By VAUGHAN CORNISH, D.Sc., F.G.S., F.C.S., F.R.G.S.

Introduction.

On December 5, 1900, I left England for Canada, accompanied by my wife, in order to study surface forms of snow. Our primary object, in this, was to continue the investigation of terrestrial surface waves and wave-like surfaces, without, however, confining our attention entirely to the study of such forms or motions of the snow as might be wave-like in character.

Our choice of Canada as the field for snow-study was determined to a great extent by the facilities for travel afforded by the Canadian Pacific Railway. The contrast between the hardship and exposure which attended the actual observations and the comfort of the well-appointed hotels and railroad cars was not the least remarkable of our experiences. All connected with the company with whom we came in contact welcomed us and gave us most effective help, and, in particular, we owe much to the kindly interest taken in our work by Sir Wm. Van Horne and Sir Thomas Shaunessey.

We arrived at Montreal on December 15, and remained in Canada until March 4, during which time scientific observations of snow were made on seventy-eight days.

The time-table was as follows :—

Montreal, December 15 to January 15.

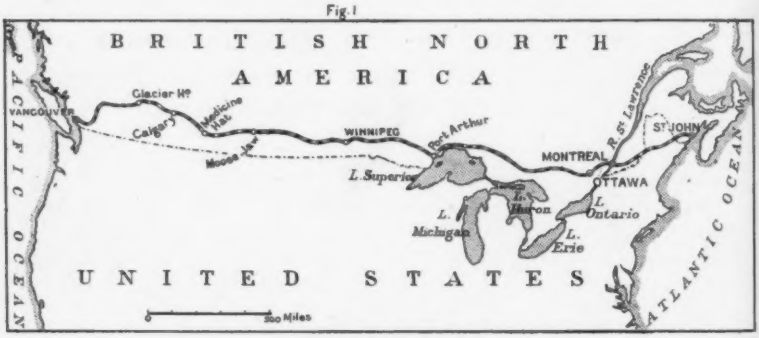
Winnipeg, January 17 to 30.

* Read in part at the Royal Geographical Society, May 12, 1902. The illustrations are from photographs and drawings by the author.

Glacier House, B.C., February 4 to 12.
Winnipeg, February 15 to 24.
Montreal, February 26 to March 4.

The intervals of travelling on the Canadian Pacific Railway were not the least instructive portion of the tour, for the snow-waves, etc., being passed in great number, the notion of typical forms was obtained by summation, in much the same fashion as one derives one's notion of the forms of waves at sea. Of course, the sight of *new* forms from the window or rear platform of a railway train may convey misleading ideas, but in this case the forms had been studied day by day in the course of snowshoe tramps, and their subsequent summation over hundreds of miles of snow-covered country was therefore not likely to mislead. The whole 3000 miles of country through which we passed was snow-covered, with the exception of a few miles near Vancouver, both on the outward and on the return journey (Fig. 1).

Fig. 1



SKETCH MAP OF ROUTE

Topographical Grouping of Snow-forms.

Of fresh-fallen snow there appear to be two chief kinds—wet and sticky snow, which falls about 32° Fahr.; and dry slippery snow, which falls at about 0° Fahr. or at any lower temperature.* The subsequent

* The following description of the characters of fresh-fallen snow and their relation to temperature is the best with which I am acquainted. The temperatures are given on the Centigrade system:—

"Schnee fällt in den Alpen und wohl überall am häufigsten zwischen +4° und −8° Schneefälle bis zu + 8° und bei −12° sind ausnahmweise auch schon beobachtet worden und offenbar auf starke Temperaturunterschiede der untersten Luftschicht, in welcher das Thermometer abgelesen worden ist, und der wenig höheren Schichten, in welcher sich der Schnee gebildet hatte, zurückzuführen. Der unter 0° fallende Schnee ist trocken, feinflockig, flimmernd, er besteht nur aus vereinzelten Eiskryställchen oder Drillungsgruppen derselben, aus kleinen ebenen Sternchen. Er ballt sich nicht, bleibt locker und leicht beweglich und hängt sich deshalb nicht leicht an Gegenstände und allzusteile Gehänge an. Fällt Schnee nahe an 0° oder darüber, so regelieren die sich berührenden Eiskrystalle su zusammengesetzen Flocken, welche bis zu 5 cm.

modifications of the snow appear to depend upon pressure, temperature, radiation and wind.

In Canada there was a geographical distribution of the kinds of snow. Near Montreal it was, on the whole, only moderately dry, and during December did not differ very much from what we saw in Scotland, on the Pentland Hills and near Grantown-on-Spey, during February, 1900, except that the freshly fallen flakes did not cling together to form mottling and rippling.* The forms of the snow-drifts, or banks, in the neighbourhood of obstacles were not very dissimilar. The same general character of snow was observed as far west as Port Arthur, 1000 miles by rail from Montreal, the surface of the snow being generally soft. Near Winnipeg and westwards, at least as far as Medicine Hat, the appearance of the snow-banks accumulated in the neighbourhood of obstacles was strikingly different. Here the snow is almost perfectly dry, and the snowfall light. The prairie was often swept quite bare of snow in the neighbourhood of the banks, and the surface of the snow on the prairie was generally hard and rough. But for its whiteness the landscape resembled a desert with low isolated sand-hills more than a snow-scene in England. Much of this snow was granular, like sand, as the result of processes which it had undergone since its deposition.

On reaching the Rockies, the snow was seen to resemble more that of eastern Canada, but afterwards it became, apparently, still more moist, so that, in the next range, the Selkirks, we met with perfect examples of the forms which gravity imparts to moist snow. Throughout the whole 96 miles from Golden to Revelstoke, the deep snow took on what a mineralogist might term a reniform habit, and in the 10 miles on either side of Selkirk summit, from a little east of Bear Creek to a little west of Ross Peak Siding, the "snow-mushrooms," as the railway people call them, attained a really startling development.

Thus we saw in the prairies of Quebec and Ontario the forms of fairly dry snow with fairly heavy fall and a fair amount of wind, in a country with a moderate amount of tree shelter; in Manitoba and Assiniboia, the forms of cold, dry snow, with a small snowfall and much wind in a very open country; in the Selkirks, B.C., the perfecting and glorification of that class of snow-scene which from time to time delights our eyes in England, when a heavy fall of clinging snow clothes our trees and shrubs as with a winter foliage and fruit. In the Selkirk valleys the snow usually falls in large flakes in a calm atmosphere at a temperature near the melting-point. Although low temperatures are experienced, the surface snow does not, in these calm valleys, acquire the

Durchmesser erlangen können. Der grossflockige Schnee flimmert wenig oder nicht, er ist schwerer, ballt sich und hängt sich überall an" ('Handbuch der Gletscherkunde,' von Dr. Albert Heim (1885), pp. 81, 82).

* See Appendix.

indurated and granular character so common on the open prairie. On the other hand, the great depth of snow—about 5 feet at the time of our visit—welds the lower layers into a compact and tenacious mass. Here the whole snowfall is not turned over and over by the wind, as on the prairie, where the snow which is exposed on the surface is often a material which has undergone compression by superincumbent snow, since removed.

Thus the snow near Winnipeg (Manitoba), and that near Glacier House, B.C., in the Selkirks, were found to be excellent examples of the opposite kinds, viz. dry and damp snow, the difference of surface forms being further accentuated by the fact that the former locality has a windy climate, and the latter a calm atmosphere. The snow-forms near Montreal, and for some hundreds of miles westward, are less perfect examples of those produced by wind acting upon dry snow.

At Winnipeg we have drift and erosion forms, succeeding one another in a horizontal sense; at Glacier House we have forms arising from excess or defect of deposition, viz. bosses and hollows, the latter often below the former when the boss or cap shelters the ground beneath, as by an umbrella.

Only a slight reference will be needed to the meteorological conditions at Winnipeg and at Glacier House in order to see how the opposite types of snow come to be so well represented at the two places. The Selkirks extract an enormous snowfall from the moist airs of the Pacific. Winnipeg, on the other hand, has not only a dry winter climate, but is so far to the east of the Rockies as to be beyond the region of the "chinook" winds, the extra warmth of which is the thermal equivalent of the precipitation on the west of the mountains. Thus the early snows at Winnipeg may remain on the ground all the winter, taking on forms and consistence very different from those of fresh snow. Westwards, in the ranching districts of the prairie, the "chinook" licks up the snow at intervals throughout the winter.

I now pass to the more detailed description of snow-forms, which involves in places a repetition, with amplification, of parts of the present section.

I say nothing here of the curious undulations produced by sledges upon the snow-covered roads of Montreal, as I hope to deal with them in another paper.

Snow-"mushrooms" and Other Bosses.

These are formed in moist snow, and were studied in the neighbourhood of Glacier House from February 4 to 12, 1901. Regular observations of temperature and snowfall are taken by the station-master; at the date of our visit the registered snowfall was 25 feet, and the depth of snow upon the ground was 5 feet. There was no sign of drift in the valley. According to the concurrent testimony of railway officials

stationed here, most of the snow falls at or above 32° Fahr., so that, although zero weather is often experienced, the snow as it falls is adhesive. I was informed also that the air is usually calm during the snowfalls.

I was informed by three persons that a snowfall of 12 inches in an hour is not unknown here. I have never had the fortune to observe such a fall as this, but it must look as if the snowflakes occupied a large fraction of the total air-space. Nevertheless, as the rate of subsidence of the flakes is, I find, 2 miles per hour, the column of air of 1 square foot section which contains 1 cubic foot of snow is 2 miles, *i.e.* 10,560 feet high. It appears to be generally the case that the eye conveys an utterly misleading idea of the relative contents of a number of small particles and of the space in which they are distributed.

In the prairies near Winnipeg, rigid prominences stand out free from snow, at least on their upper and windward faces, but cause large detached drifts to accumulate in their neighbourhood, a small drift being also usually attached to the leeside of the obstruction. At Glacier House, on the contrary, the chief feature produced by the prominence is a concretionary growth based upon its upper surface, beyond which it ultimately extends with overhanging eaves. There is also sometimes a mass of snow attached to the windward side of the obstruction.

In the case of the drifts of the prairie snow, the prominence of the snow-banks is increased by the deficiency of snow to leeward of, and between the enclosing arms of, the snow-bank. In the case of the

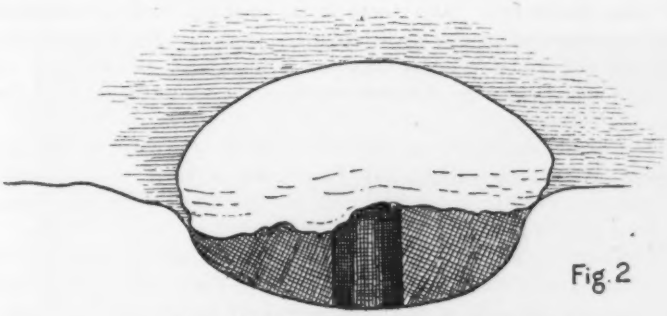


Fig. 2

Snow Mushroom with hollow beneath, from a photograph.

mushroom-like caps upon the tree-stumps at Glacier House, the associated depression is beneath, where the ground is sheltered as by an umbrella (Fig. 2).

In felling the trees a stump of several feet in height is always

left, and this is the stalk of the "mushroom." When the stumps are short, the rim of the snow-cap touches the surrounding snow surface, and the appearance is then an ordinary boss instead of a "mushroom."

Heim describes * the formation of overhanging cornices of snow by the adhesion of the flakes of moist snow (at about 32° Fahr.) when eddying round in a wind on the lee side of an Alpine ridge. The bosses and caps on the tree-stumps at Glacier are so far similar to these snow cornices that their projecting eave is due to such adhesion. Their spheroidal shape, however, does not conform to active modelling by eddies. In one spot where the "mushrooms" were exposed to gusts of wind coming down a glacier valley, this fact was well illustrated by the remodelling of the spheroidal cap to a shape resembling that of a peg-top, but with edges meeting at the point.

The snow-mushrooms, as we saw them in February, appeared to have attained to perfect spheroidal symmetry as the result of a completed growth upon the circular platform of a cylindrical pedestal. (Fig. 3, Plate I.).

I proceed to give an account of the process of growth of the snow-mushroom, as inferred (*a*) from observation of the completed structure; (*b*) from my observations at various times of the occurrences during the fall of moist snow in Canada, Britain, Switzerland, and the Tyrol; and (*c*) from the probable operation of *regelation*.

Moist snowflakes adhere far better to a snow surface than to any other. When the wind is light, which is the case we have here to deal with, the snow surface remains rough, presenting many points for attachment, and perhaps diminishing the already small velocity of the air near the surface. Also there is no melting, such as sometimes hinders accumulation of snow upon foreign surfaces. But I expect that the most important factor in such concretionary growth is union by solidification of the films of moisture where the snowflake touches the snow surface.

The upper surface of this snowflake, which is exposed to the air, remains moist until another flake falls upon it, when, as I suppose, the surfaces in contact are united, as above, by a thin layer of ice, which is then a part of the structure of each snowflake.

The touching surfaces must be, in the first case, a very small fraction of the total area of surface of the snowflake. As the depth of the deposit increases, the pressure of the superincumbent layers slowly squeezes air out of the lower layers. These become more compact and more tenacious both by the filling up of interstices by repacking of material, and also by regelation.

When I attempted to detach a small snow-mushroom from its pedestal, I found that it was very firmly fixed. Having driven a long pole into the mass of snow, which was about 4 feet across, I found it to

* 'Gletscherkunde.'

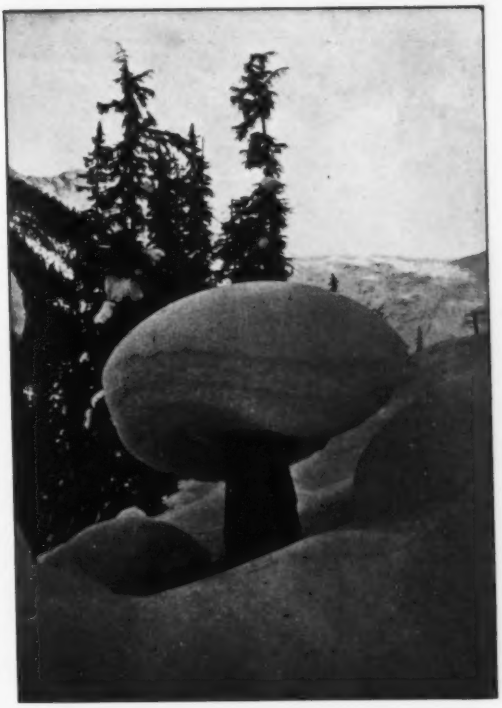


FIG. 3.

A SNOW MUSHROOM NINE FEET IN DIAMETER.

Engraved and Printed by John Bale, Sons and Danielsson, Ltd.

FIG. 9.

MOVING SNOW-WAVES—TEMPERATURE 8° F.

be tough and tenacious, and I was unable to dislodge it. The pedestal was a broken, rotten, tree, about 1 foot in diameter and 12 feet high. Placing my pole against the tree, I gave successive pushes until the tree rocked violently, when at last the snow-cap fell, but as a whole, and it was not broken with its impact with the soft snow beneath.

Some concretionary action during deposition is usual in a quiet fall of snow in England, and when the flakes have ceased to fall, we see the rounded masses of snow clinging to, and weighing down, the twigs and branches of trees. As soon, however, as a breeze begins to make a stir amongst the branches, they shake off the greater part of their burden. Upon the rigid bases of posts, walls, railings, and tree-stumps the capping of snow is more stable, but with us in England the depth of the snow is not usually sufficient to weld the lower layers into a tenacious mass.

At Glacier House the mushrooms, on all but the largest tree-stumps, were probably as large as the pedestal was capable of supporting, *i.e.* the eaves of snow overhung the support as far as possible consistently with the limit of cohesion of the material and the size of the base. A stump 2 feet in diameter had a cap of snow 9 feet across, the eaves projecting 3 feet 6 inches all round the pedestal. The largest tree-stumps would probably have supported somewhat greater snow-caps had the depth of snow been greater; but, as well as I could judge, the projection of the eaves was as great as was consistent with the amount of snow which had fallen, and with the cohesion of the material. A broken tree with diameter of 4 feet had a snow-cap 12 feet across, the eaves projecting 4 feet beyond the pedestal. Some of these snow-mushrooms must have weighed a ton.

The interesting question now arises—What happens when more snow falls upon a fully-grown mushroom?

If the strata of successive snowfalls remained horizontal in the eave of a snow-cap, then, as the strain would be greatest at or near where the leverage is greatest, the eave would break off close to the pedestal. Thus where there are many fully grown mushrooms we should, if their structure were of this kind, expect to see in their company the ruins of a considerable number which had received rather more snow than they could support. In point of fact, however, there was scarcely a tree-stump of 2 feet or more diameter near Glacier House of which the snow-cap was in ruin. The absence of ruins, of considerable breakage, and even of untidy fragments, contributed greatly to the beautiful and singular appearance of the mushroom tract.

That the snow-mushroom is, on the whole, so remarkably preserved from sudden ruin by overloading I attribute to bending of the strata under the action of gravity, their inclination to the horizon increasing with the distance from the pedestal. In the numerous photographs which I obtained, the rough edge of the rim (*a*, *a*, Fig. 4) is strikingly

contrasted with the smooth dome *b*, *b*. The rough edges show where the pendant strata have broken off by their own weight without ruining the whole structure.

There is also another means by which this structure can get rid of additional snow deposited upon it, viz. by the slipping of the loose

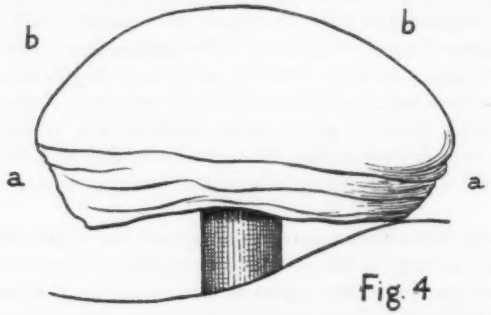


Fig. 4

Snow Mushroom showing rough ends of outcropping strata a, a, and smooth dome b, b, from a photograph.

surface layer from the highly inclined lower strata near the rim of the mushroom. This slipping may be assisted by lubrication of the harder subjacent stratum when surface snow is melted by the sun. I saw snow melt in the sun during hard frost in February at Glacier House (Figs. 5, 6, 7, and 8).

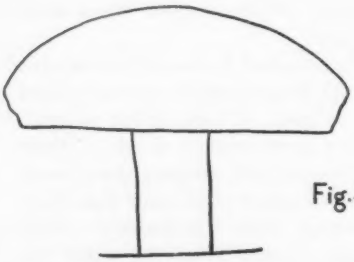


Fig. 5

Snow Mushroom, elevation.

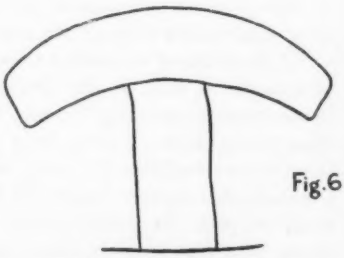


Fig. 6

Snow Mushroom, section.

The perfect representation of a mushroom by the snow-caps on the tree-stumps at Glacier House is largely an accident of proportion between the amount of the snowfall, the diameter of the forest trees, and the height of stump usually left in felling. Where the trees are small, as in those parts of the Rockies through which we passed, the base cannot support a sufficient quantity of snow, and, on the other hand, nearer the

Pacific coast, where the trees are of giant growth (with a diameter often of 14 feet), the snow-cap appears more as a thatch with overhanging eaves.

Above Glacier House Hotel I crossed a mountain stream on the snow-bridge provided by the union of the projecting snow-caps which had formed upon the large boulders. A snow-bridge, being a synclinal structure, has a mechanical advantage over the anticlinal structure of the individual snow-cap, especially in its resistance during slight thaw.

In the forest, however, the bridging over of spaces which occurs with sticky snow renders the surface treacherous. This is more particularly the case among bushes or scrub, where the snow does not pack.

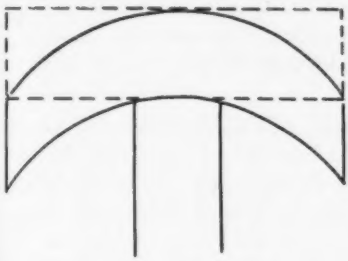


Fig. 7

Snow Mushroom, illustrating bending under gravity.

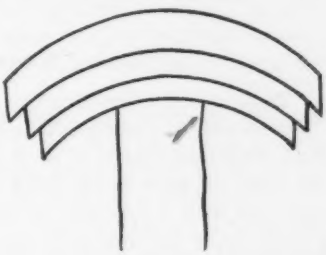


Fig. 8

Snow Mushroom, scheme of supposed stages of growth.

An illustrated article which I wrote for *Pearson's Magazine* (on "Snow-mushrooms," December, 1901) has brought me an interesting letter from Mr. Howard Chapman of Victoria, B.C., from which I extract the following passages:—

"The past two winters the average snowfall in British Columbia has been very slight; at Glacier House it is always pretty heavy. The average fall there for the winter is 48 feet. In the Lardeau it is about the same, but the timber is much larger. . . . I have seen the snow overhanging the stumps in this section for 8 feet all round. There are four districts in British Columbia that I know where you will find this particular growth, and they are all somewhat near. The first is Glacier House; the second between Revelstoke and Arrowhead, on the branch line to Kootenay; the third in the Lardeau; and the fourth between Lardeau and Kaslo, upon the K. and S. railway, at a little place called Whitewater; but in neither place do they grow as large as in the Lardeau. The cause [of the 'mushroom' growth] is the entire absence of wind during the whole winter."

A resident at Glacier House, in transmitting some notes on the snow-mushrooms observed there during 1901–2, says—

"From the first the mushrooms are symmetrical; the stump is round, of course, and as soon as it is covered, the snow, which is soft and tenacious, gradually extends smoothly over the edge. The trunks of the trees do not carry much snow; it generally falls straight down, and loads the branches, but not the trunks."

Before leaving the subject of snow-mushrooms, I may point out that a well-developed specimen (*e.g.* that shown in Fig. 3, Plate I.) has a profile similar to that acquired by the "spreading chesnut tree" and other trees of similar habit, such as oak and beech. The complete form is best seen where, cattle being excluded, the lower branches sweep the ground. As in the case of the snow-mushroom, the form is due to bending under the action of gravity.

Normal Waves of Drifting Snow.

These are only formed in dry snow.

Previously to visiting Canada I had seen and described (see Appendix) small ripple structures in snow which had their steeper slope facing the wind, the snow being either damp or compacted. I had not, however, seen what I may term *normal* ripples, *i.e.* those which have their steeper face to leeward, as the ripples of loose sand have; neither had I seen snow freely drifting in larger ridges, such as those near Helwan, which I have described and photographed, formed by wind in loose sand,* or those formed by a strong current of water flowing over sand-banks in the estuary of the River Dovey, North Wales, and elsewhere.†

I first saw the normal waves of drifting snow near Montreal on January 5, and I subsequently found that the tendency of cold, dry, falling, or fresh-fallen, snow, to go into such waves is a characteristic and important feature of snowfall and snow-drift in a cold climate.

Fig. 9, Plate I., shows the group of waves met with on January 5 at 10.30 a.m., temperature about 8° below zero Fahrenheit, which were creeping towards the camera with a visible motion. The average wind velocity throughout the day was 30 miles per hour according to the record of McGill College Observatory. The wind was removing from the more exposed places a fresh-fallen layer of three inches of dry snow, drifting it to the shelter of the hedgerows and copsewood. This group of waves was formed on the lee of a swell in the ground, where, at the time, more snow was being deposited than the wind could immediately remove. Four hours afterwards this group of waves had nearly disappeared, probably because the supply of snow-drift was no longer sufficient; but similar waves had made their appearance further to

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* "On Sand-dunes bordering the Nile Delta," *Geographical Journal*, January, 1900, fig. 21.

† "On Sand-waves in Tidal Currents," *Geographical Journal*, August, 1901, plate 2.

leeward. The average dimensions of the waves, when photographed in the morning, were—

$$\text{Wave-length} = 15 \text{ feet } 10{\cdot}4 \text{ inches}$$
$$\text{height} = 4{\cdot}9 \text{ inches}$$
$$\therefore \frac{\text{av. length}}{\text{av. height}} = 38{\cdot}86$$

The waves moved 6·52 feet in 40 minutes, which is equal to an *average* rate of 1·96 inches per minute, which, of course, must be less than the speed during gusts, and more than that during lulls.

A later observation at Winnipeg also indicated "inches per minute" as the speed of the snow-waves. On comparing this with a few measurements of Æolian sand-waves of similar dimensions which I made in Egypt, I infer that sand-waves of the same height or of the same wave-length would travel one or two-tenths of an inch, instead of one or two inches, in a minute.

These waves move by depletion from the windward side, and accumulation on the steep lee face. The latter takes place both by snow falling over the crest and by snow swept back towards the cliff from the ground to leeward. As in similar cases with sand-waves, there is a tendency for the first ridge of the group (at the weather end) to be scoured away, and for a new ridge to form beyond the original group to leeward, so that we may have two velocities, that of the individual wave and that of the group of waves. Not all the snow which was drifting here was drifting in the waves, they contained only the surplus which the wind was unable to waft in continuous suspension. A cinematograph picture of these waves would have been interesting; for the slow wave-motion of the ridges contrasted in a curious and instructive manner with the wild whirl of the drift, or current, of snow, and this, of course, does not appear in a stationary photograph.

The waves were not rippled on the surface as the corresponding sand-waves are. The formation of normal ripples in granular snow, and their non-formation in non-granular snow when the latter is falling into waves, confirm my view that the Æolian sand-ripples are caused by the resistances of the individual grains of the surface.*

On January 6 I found waves, formed on the 5th, already reduced to mere stationary ridges of wave-like form, no longer moving before the wind, owing to their surface having "set" hard. There had been no thaw.

On January 10 I saw waves being formed, not as a part of the process of removal, but of that covering the ground with snow. The fall began at 10.30 a.m., and did not cease as long as daylight lasted. It consisted mostly of needles of dry snow one-eighth of an inch long by one-eightieth broad, falling in a moderate breeze at about 14° Fahr. The rate

* The author "On the Formation of Sand-dunes," *Geographical Journal*, March, 1897.

of deposit in the morning was about half an inch per hour. Footprints were refilled to a depth of 1 inch in fifteen minutes, or eight times as fast as the average rate of accumulation. I selected an exposed position, and observed the mode of accumulation of the fresh snow on the icy surface caused by the sharp night's frost which had succeeded to a rapid thaw on January 9.

The fresh snow at eleven o'clock was distributed in patches, which grew in size and number at the expense of the intervening icy ground, but remained irregular in shape and distribution up to 12.30 p.m., when I left. Returning at 2.30 p.m., I found that these irregular patches of snow had become ridges transverse to the not very strong wind, with a cliff on the lee side, with the normal form of waves of drifting powders, and grouped so as to admit of measurement, distances between successive cliffs being 6, 12, 6, 8, and 7 feet. The waves were even visible, in spite of the bad light, in places where the frozen ground was completely covered with fresh snow. A boarded, or "plank," path at the side of a road near by remained still uncovered at 4.15 p.m., and with the actual density of snowfall and strength of wind would never be covered *except by submergence under a travelling wave of snow.*

Later observations on frozen lakes showed that waves thus rolling onward generally leave a thin coating of the lower compressed layers, forming a surface which retains better the falling snow, and thus assists to complete the covering of a smooth or rigid surface.

On January 13 I found the loose snow covering the smooth tracts of ice on the frozen St. Lawrence to be all in waves. The depth of snow covering the level ice was 7·45 inches at the trough, and 11·75 inches at the crest of a wave. Ten successive waves had an average length of 10 feet, and the lateral extension was many times as great as the wave-length. Near the banks of the river the wave-fronts were curved backwards, as is the case with the *current mark* in sandy streams.

During the railway journey from Montreal to Winnipeg, many groups of snow-waves were seen, most of which were on the level ice of lakes, or of wide reaches of rivers, the ice being entirely snow-covered. On our return journey in February, when the bays on the north coast of Lake Superior were frozen, the tendency for the snow to go into waves on smooth ice was also well seen. It appeared that the snow had not come in sufficient quantity to cover all the surface, so that the billows of snow were separated by dark ice. The snow apparently had "set" after deposition, and subsequent wind had reduced the ridges to "basal wrecks" (as a geologist might say), but had left the ground-plan of the waves intact. A satisfactory photograph was obtained of these. This greater prevalence of waves of the drifted material upon an extensive horizontal surface, rigid and smooth, is a striking confirmation of my view that such waves, associated in their origin with

the sinuous or wavy flow proper to high speeds,* grow by a tendency to alternate silting and scouring, which, in the case of tidal sand-waves, I have already dealt with,† and which is, perhaps, equally an original condition. In the beginnings of accumulation of snowfall the difference of frictional resistance upon a bed of fresh-fallen snow and upon smooth ice immensely increases the tendency to alternate silting and scouring, for it is evident that wherever a patch of snow succeeds in lodging, the rate of drift is there much slower than, probably only a small fraction of, the rate of drifting upon the smooth ice.

Even when the surface is all covered with fresh snow, an extensive horizontal plain appears to be the best field for the growth of waves, for the liability to local *surcharge* increases with the extent of the field of drifting. Next to the lakes, the flat and open prairie on the north-east of Winnipeg was the best ground which I saw for their development. Where the country is undulating, I frequently saw the waves forming to leeward of a swell in the ground, and, in enclosed country, trains of waves were often formed where much snow had deposited near fences, or outside copses, but, notwithstanding this fact, fixed inequalities or obstacles are, *on the whole*, unfavourable to the development of waves. The more unlevel is the country, and the more numerous the places of shelter, the shorter is the time during which the wind can drift the snow in waves, and the smaller is the extension of the individual groups of waves.

At Winnipeg there were three days which were pre-eminently instructive in the matter of wave-formation. On the morning of January 23, when I had been there a week, and knew where waves were wont to form, I went on to the open prairie in a full gale of wind, in high hopes of a fine demonstration of wave-making. Snow was falling (about 1 to 1½ inches during the day), and the drift hid the lower stories of the houses as I looked back towards the town. Although it was impossible to see far ahead, the detail of the surface at one's feet was clear enough. Not the vestige of a wave was formed during the whole morning. The temperature was about 20° Fahr. when I first went out, and remained high during the morning. The snow came down in fluffy stars one-eighth of an inch diameter, which stuck to every twig of the trees, even in the open, and wooden palings were plastered with snow on the windward side. In a copse, the surface was rippled or mottled in the manner familiar to us in England and Scotland.

* See Osborne Reynolds, "An Experimental Investigation of the Circumstances which determine whether the Motion of Water shall be Direct or Sinuous," *Phil. Trans.*, clxxiv. pt. iii. pp. 935–982.

† The author, in *Scottish Geographical Magazine*, January, 1901, "On the Formation of Wave-surfaces in Sand;" and *Geographical Journal*, August, 1901, "On Sand-waves in Tidal Currents."

In the open, the snow which collected in depressions had a felt-like consistency, and the excavations eroded by the wind were irregular in shape and jagged in outline, such as might be produced if a felted material were torn by teeth.

On February 17, at Winnipeg, snow fell all day, and I think during a great part of the night, without wind. By the morning of the 18th there was, I estimated, 5 inches of fresh snow which had been evenly deposited. The temperatures on the 18th (in the streets of the city) were, 4 a.m., 5°; 1 p.m., 5°; 3 p.m., 3°; 9 p.m., −3°; 12 p.m., −4° Fahr. As it was blowing pretty strongly, I went out about 9.30 a.m. to the most exposed part of the prairie, and found that the ground was entirely occupied by immense series of snow-waves.

Twenty-nine waves of one series gave the following measurements:—

$$\text{Average wave-length} = 30 \text{ feet } 1 \text{ inch}$$
$$\text{average height} = 7{\cdot}19 \text{ inches}$$
$$\frac{\text{average length}}{\text{average height}} = 50{\cdot}2$$

Average difference between each wave-length and that succeeding = 22·2 per cent. of the average wave-length. This percentage may be termed "the variation" of the group (Figs. 11 and 12).

Another series, practically unbroken, comprised one hundred and ten consecutive waves with an average wave-length of 32 feet 10 inches; this group was measured later in the morning, and "the variation" was greater, viz. 36·55 per cent.

The reason for this deterioration was evident at the time. As the waves rolled on, the lower layers, consolidated by pressure, became exposed, and these could not conform to the shapes and movements of the looser parts, and gradually, in the course of this and the two following days, the appearance of the prairie underwent the complete transformation from that due to forms of accumulation to that of forms of erosion, having their steeper face towards the wind.

It is the readiness with which loose snow is transformed into a compact though friable material, and the rapidity with which a crust forms upon the surface, which prevents the snow-waves from growing to large size. Were it otherwise, the difficulty of winter travelling in cold countries would be much increased.*

When the amount of dry drifting snow is not large, the tendency is not to form series of ridges whose lateral extension is much greater than the wave-length, but to produce deposits the ground-plan of which is of the type shown in Fig. 10, which is intermediate between the transverse ridges and the barchan or medaño shape. In this figure the wind is from the right.

* Perhaps the caking of dust, when moistened, hinders the formation of dust-dunes in dry climates.

Snow-barchans or snow-medaños were found on the frozen Red River near Winnipeg, and on the frozen St. Lawrence (towards the end of the winter), but were seen in greatest number and perfection from the railway train on the rolling prairie, a little to the west of Moose Jaw. At Boharn I find noted that we had "passed hundreds of 'barchans' in the last quarter of an hour, this being here the normal form;" yet it is not easy to find a good example to photograph. I do not think that they were so perfectly well formed as in sand, which would be due to the more ready "setting" of the snow; and their greater flatness and narrowness increases the difficulty of taking a photograph, especially when one cannot secure an elevated position for the camera.

An intermediate form of Snow wave. ground plan.

Fig. 13 comprises a drawing made from a photograph of a snow-barchan of non-granular snow, and another made from the photograph of a barchan of dry Nile sand, which is Fig. 25 of the paper on "Sand-dunes bordering the Nile Delta" (*Geographical Journal*, January, 1901).

The narrowness of the snow-barchan I attribute to the same cause as the flatness of this and other snow-waves, viz. to the circumstance that the material is able to offer but little resistance to the wind.* The sand-barchan is composed of fine Nile sand. A barchan of coarser sand would probably be bluffer at the bow or windward end.

In this connection I may refer to a fact which came out clearly in my investigation of tidal sand-waves, but was not explained in the paper, viz. that the sand-waves formed by a current of water are steeper (nearly 1 : 12) than those formed by wind (about 1 : 18). Is this greater steepness due to a difference between submerged and dry sand, or is it due to a difference between air and water? I think mainly to the latter, the particular difference which ought to cause greater steepness of the water-formed ridges being the smaller ratio of viscosity to density in the case of water. The result of this should be that if an obstruction cause a vertical sinuosity in the movement of air, the sinuosities to leeward thereof would each be much flatter than the last, whereas in a rapid current of water the rate of

* The lee slope of the snow-waves at Winnipeg was about 30°, approximately the same as that of loose sand. I suppose, therefore, that the friction between the snow-grains bore the same proportion to that between sand-grains as the density of the snow does to the density of sand. The specific gravity of this snow was 0·38. A determination of apparent specific gravity of sea-shore sand gave 1·6, or say four times that of the snow.

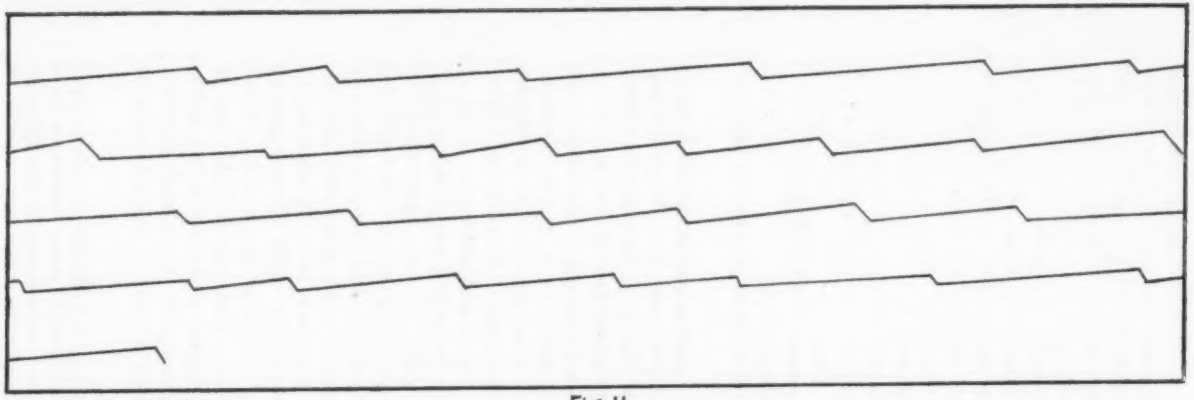


Fig. 11.
Profile of twentynine snow waves, near Winnipeg. Horizontal Scale 1 inch = 32 feet, Vertical Scale 1 inch = 8 feet

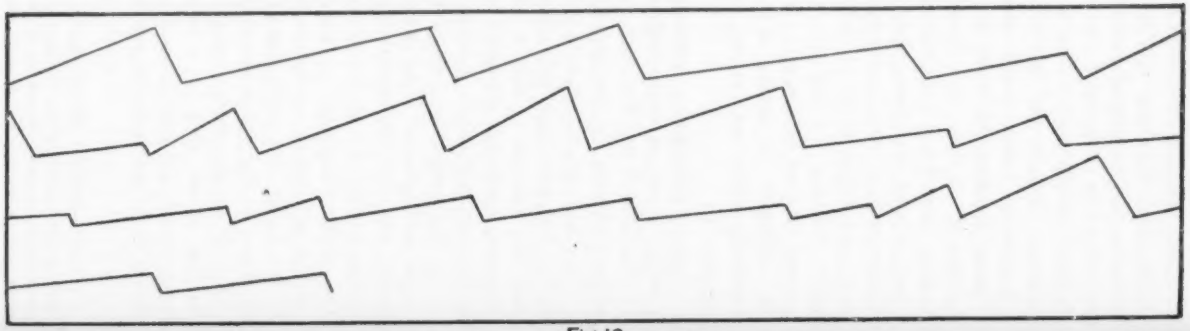


Fig. 12
Profile of twentyfour æolian sand waves near Helwan, Egypt.
Horizontal Scale 1 inch = 32 feet, Vertical Scale 1 inch = 8 feet

flattening out would be much slower. But I think water will roll sand-grains along the bottom when the velocity of the water is below the critical value at which the fluid becomes "wavy." Air, on the other hand, has attained the "wavy" velocity before it will shift ordinary sand at all. What a sand-ridge has to withstand, much depends upon how the stream is directed relatively to the surface. The weathermost ridge deflects the current so as to assist the maintenance of the ridges to leeward, and the more perfectly the fluid can of itself maintain its vertical sinuosities, the less there is for the ridges to resist, and consequently they can grow steeper and thinner before their limit of growth is reached.

The snow-barchans appeared to me to be drawn out, so to speak, as

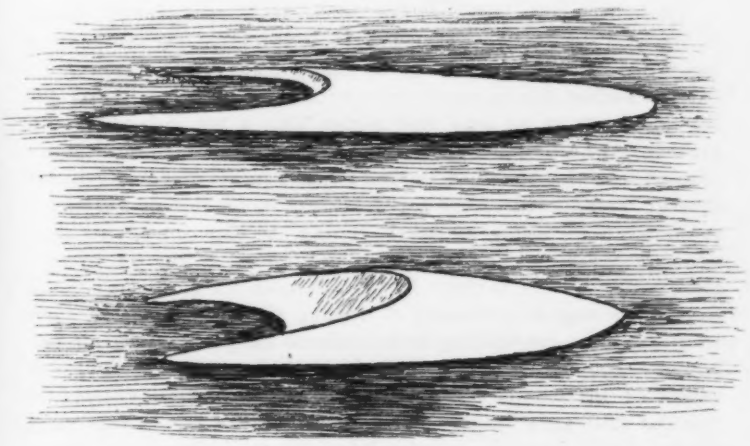


Fig. 13
Barchans of snow and sand, from photographs.

they travelled, the weather slope becoming longer and flatter. This effect I refer to the greater coherence of the snow which had been subjected to pressure, so that the weather slope dragged behind. In the case of any sand which had a distinct tendency to bind or set, one would expect to find a similar effect, and this may perhaps assist to produce longitudinal sand-dunes from barchans.

The remaining observations of snow-barchans were on a day when they were curiously evolved from normal ripples in granular snow, and I shall therefore now commence the description of ripples while continuing that of barchans.

Normal Ripples of Granular Drifting Snow.

I was not so fortunate as to observe the actual formation of the snow-sand and snow-gravel, although I lingered at Winnipeg on our second visit in the hopes of being present at the process. No doubt one of the most effective means for the production of such snow is the formation of an icy crust by re-freezing after thaw, and the breaking up of this by the under-cutting of the wind. Snow consolidated by pressure also yields lumps which probably rub down into fairly hard granules, and the snow which has drifted in waves sets hard upon the surface during the cold nights, and this crust perhaps yields material for the snow-sand. For the rest, I suppose that a good deal of what has been written about *névé* may be applied to the case of snow which has lain some time upon the prairie.

On January 25, in "zero weather" at Winnipeg, the average velocity of the wind for the twenty-four hours was 26·8 miles per hour, according to the weather report of the St. John's College. The snow had a hard-set surface, due to severe frost (without any previous thaw), and the drift snow at no time rose higher than a few inches from the ground. At 11 a.m., having come across a meat-tin embedded in the compact snow, I removed it, leaving a hole 4 inches deep and 9 inches square. This the drift filled to a depth of 3 inches in nine minutes, or at the rate of 20 inches per hour. During the nine minutes no snow whatever had accumulated in the neighbourhood of the tin, which I had placed upon the surface. In the afternoon the sun came out, and there was a magnificent display of rippling, the best during the whole winter, but the low-drifting snow rendered the photographs unsatisfactory. The drifting snow accumulated in depressions of the rough surface of the old hard snow. These patches of freshly deposited granular drift snow quickly fell into ripples like the Æolian sand-ripples, which increased in wave-length more rapidly than Æolian sand-ripples do.

A ridge of 9 inches wave-length travelled that distance in 110 seconds, *i.e.* at a velocity of 4·9 inches per minute. Æolian sand-ripples of the same wave-length in a wind of similar strength, observed on the sandhills, Poole Haven, Dorset, February 4, 1896, travelled 12·25 inches in twenty minutes, *i.e.* with a velocity of 0·61 inch per minute, and others with a wave-length of 4 inches, situated in a more sheltered position close by, travelled at the rate of 0·41 inch per minute.

Thus it appears probable that a wind produces about the same rate of advance in both ripples and waves of a powder, and that this rate is greater for dry snow than for sand. More measurements of these rates would be valuable.

For a time all the ripples in a patch of the drift snow grew at the same rate, thus preserving approximate equality among themselves;

but presently a new thing occurred, namely, the ridge furthest to windward began rapidly to outgrow the others. I suppose this happened when the patch of drift snow had risen as high as, or higher than, its surroundings. A deflection of the wind due to the growth of the weathermost ridge was soon observed, and some of the drift snow in the centre of the patch began to travel backwards against the wind. This effect was speedily followed by failure of the ripples, which became indistinct, and, after a time, vanished altogether, except that, in some cases at any rate, there was a little rippling left at the tips of the two horns of the now sickle-shaped or barchan drift. In *one* instance it happened that, instead of the middle line being swept bare, a tongue of snow formed there, producing the form

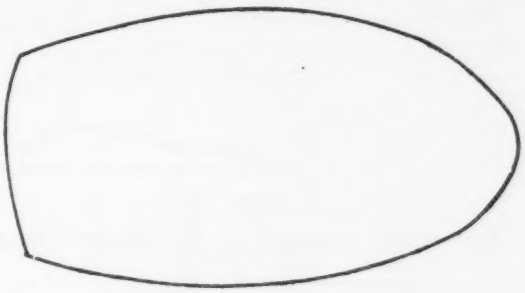


Fig. 14

A patch of rippled snow, plan. Wind from the right hand.

shown in Fig. 17, which is found also in deserts* (Figs. 14, 15, 16, and 17).

Transversely, the surface of the patch of drifted snow was level when in the rippled stage, but afterwards the weathermost ridge grew most rapidly in the middle.

The longitudinal profile undergoes yet further transformations. At first the section through the centre has a steep weather face and a long gently inclined lee face; but the slope of the weather face continually decreases, and that of the lee face increases, so that the crest travels, so to speak, through the wave.

* A. v. Middendorf, quoted by J. Walther, 'Die Denudation in der Wüste,' p. 167, "Eine zweite Form unterscheidet sich von der vorigen (the Barchan) nur dadurch, dass mitten zwischen den beiden Zungen sich eine kürzere und schroff abfallende dritte Zunge gebildet hat, die nahezu die Mittelrichtung zwischen den beiden anderen einhält."

Fig. 18, Plate II., shows a patch of rippling photographed in still weather. The ratio length ÷ height is 28·44, *i.e.* they are much flatter than Æolian sand-ripples, but steeper than the trains of snow-waves

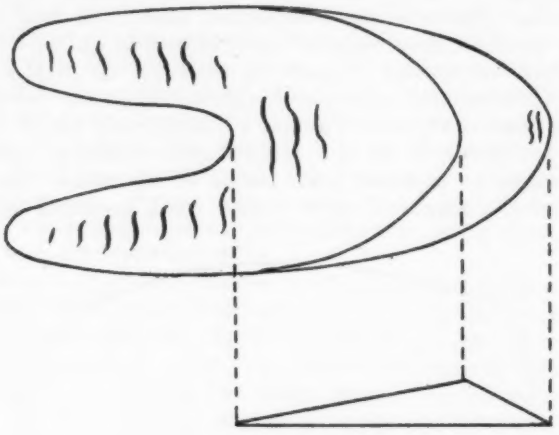


Fig. 15

Conversion of above to a Barchan, early stage.

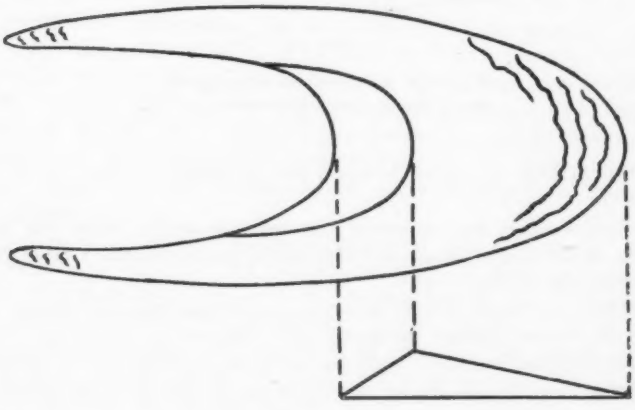


Fig. 16

The same at a later stage

which I have measured. The latter, however, were composed of snow either not granular or much less granular than the ripples, and therefore probably lighter. The snow-granules in these ripples averaged

$\frac{1}{32}$ inch in diameter, corresponding to "coarse sand."* I have seen snow of approximately granular character, but in particles $\frac{1}{64}$ inch diameter, refuse to ripple under prolonged wind-action. Snow-granules of $\frac{1}{12}$ inch to $\frac{1}{9}$ inch form well-marked patches of rippling in which the wave-fronts are not so long and straight as with the $\frac{1}{32}$-inch granules, but have a steeper windward slope. The grains of the surface layer are sometimes as much as $\frac{1}{7}$ inch average diameter. This is the size of small "gravel."

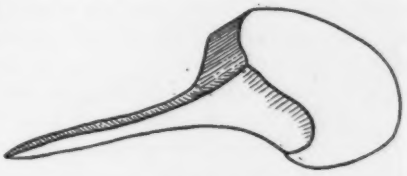


Fig. 17

Longitudinal growth on lee side of a travelling snow-drift.

The following are the detailed measurements (in inches) of the group of ripples shown in the photograph :—

No.	Length.	Height.	Length / Height
1	2·625	0·09375	28·00
2	2·625	0·09375	28·00
3	2·562	0·09375	27·33
4	2·344	0·09375	25·00
5	2·062	0·0625	33·00
6	2·000	0·0625	32·00

$$\frac{\text{Total length}}{\text{Total height}} = 28{\cdot}44$$

variation of wave-length = 4·43 per cent.

On the "Setting" and Packing of Snow.

It has been mentioned above that the snow often sets hard upon the surface during the night when there had been no previous melting, and that this property hindered the growth of large waves. Thus snow-waves formed on January 25 at Winnipeg, on the frozen river, had on the 28th a surface so hard that it was scarcely dented by the heel of the moccasin. (The highest temperature during the week ending January 29 was 24° Fahr., and the lowest −28° Fahr., according to the weather report of St. John's College, and there was no apparent melting in the sun.) This resistance was due to a layer one-eighth of an inch thick, all below being comparatively soft. Pieces of the crust, when broken off and held up to the sunlight, were seen to be a mosaic of small translucent icy blocks cemented firmly by opaque ice.

* 'Mechanical Composition of Wind Deposits.' T. A. Udden. 1891.

During nights which are cold, still, and clear, and in situations where the surface of the snow can radiate freely, I suppose that there is in the surface layers a considerable condensation of solid matter from aqueous vapour evaporating in the dry way from the lower layers of snow, under the action of the Earth's escaping heat.

On January 28, temperature 10° Fahr., snow from the upper 2 inches of some of these waves was weighed, and found to have a specific gravity of 0·38. At the same time, in a copse near by, the snow, which moreover had no crust on the surface, had a specific gravity of 0·19. This is about twice as heavy as new-fallen snow, but only half as heavy as the snow which had been chased about by the wind.

People say that the snow "dwindles away" on the prairies, and the above measurements may help to explain this. If the samples taken be truly representative, they indicate that after an interval, when 8 inches of measured snowfall would be represented in a wooded country by a 4-inch layer, there would be only a 2-inch layer on the prairie. Densities of snow were also taken at Glacier House on February 16. At the surface the specific gravity was 0·106, at the depth of 1 foot 0·195, and 4 feet 0·354. The second value is that of the surface snow in the woods at Winnipeg. It requires the pressure of more than 3 additional feet of snow to pack the material as tightly as the wind did on the prairie. The wind, by turning the material over and over, facilitates the escape of air. The pressure of superincumbent snow, on the other hand, helps the enclosed air to prevent the solid parts from coming together.

In zero weather I often found that lumps of snow were at the same time hard and light, and when thrown down upon other lumps, the noise resembled that which is made by throwing a piece of coke upon a heap of the same material. I surmise that when snow sets hard without packing, or re-freezing of films of water, the result is due to sublimation; that is to say, evaporation in the dry way and subsequent condensation from vaporous to solid form. I think it is reasonable to suppose that when sublimation goes on within a porous body, there will be excess of evaporation from the walls of the larger cavities and an excess of condensation upon the walls of the smaller cavities so that surfaces nearly in contact will be cemented together. By such means the body would become stronger and more rigid without increase of density.

Scarped Wave-surfaces, and Longitudinal Erosion Forms in Consolidated Snow.

We have seen how wind, in removing loose, dry snow, drifts it into normal waves. When the material is either too sticky or too compact it will not behave thus, but even then the wind does not remove the snow

FIG. 18.

NORMAL RIPPLES IN GRANULAR SNOW.

Engraved and Printed by John Bale, Sons and Danielsson, Ltd.

FIG. 19.

STRATIFICATION OF SNOW REVEALED BY WIND EROSION.

in uniform layers. On the contrary, any small shallow depression tends to multiply itself to leeward, owing to the deflection of the wind, which leaves the snow in shelter for some distance, and then, descending, scoops out a second depression, and afterwards a third, and so on. The series of vertical sinuosities thus formed sometimes acquire considerable lateral development, especially when they are only cut in the top layers of snow. The ridges thus formed are of two orders, corresponding to ripples and waves. The former are generally due either to falling flakes of moist snow (see Appendix) or to the stratification of the snow, which is beautifully revealed by wind-erosion. The figures and photographs (Fig. 19, Plate II., and Fig. 20) illustrate the relation of the stratification grooves or ripplings to the larger ridges.

The latter when fully developed attain a ratio of depth to length, which is much greater than that of the normal waves and ripples of the less resistant drifting snow.

The following are examples, viz. :—

Six ridges had an average wave-length of 13·75 inches, with an average irregularity of 21·45 per cent. The ratio length : height was 20. The snow was stratified. In another case of stratified snow the dimensions of one ridge were taken across seven sections, giving an average wave-length of 12·95 inches, and a ratio of length : height 15·62.

Four ridges of unstratified snow had an average wave-length of 23·7 inches, and the ratio length : height was 19·2. These were in snow on the smooth ice of the Assiniboine river. There was 1·75 inch of snow at the troughs.

In the following series of excavated ridges the (horizontal) length of the weather-facing and lee-facing slopes were separately measured (in inches) :—

Weather slope.	Lee slope.	Wave-length.	Height.	$\frac{\text{Length}}{\text{Height}}$
11	18·75	29·750	1·875	15·87
10	11·625	21·625	1·750	12·36
11·25	20·875	32·125	1·750	18·36
15·375	14·125	29·500	1·375	21·45
15	16·625	31·625	1·250	25·30

$$\frac{\text{Total length}}{\text{Total height}} = 18{\cdot}08.$$

variation of wave-lengths = 16·17 per cent.

This is the series shown in Fig. 20.

As the erosion progresses and the top layers of snow are removed, the snow-rock becomes harder, and the detritus adheres less to its surface and abrades more vigorously. Thus notches in the ridges, instead of being mended by the detritus, are increased by it, so that the transverse

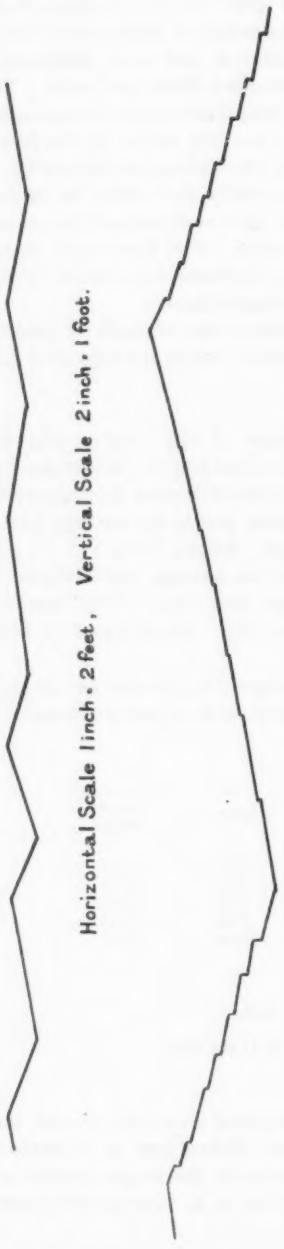


Fig. 20

Profile of undulating surface produced by wind in compact snow.

ridges are presently cut through, and we pass by stages from an arrangement of ridges transverse to the wind to that of longitudinal structures having their greatest extension parallel to the wind.

I suggest that some *longitudinal sand-dunes* are produced by a similar course of events.

Between the two extreme cases are various transition stages, in which sometimes it is the form of the depression instead of that of the salient parts which dominates the eye. Sometimes these depressions are pits shaped like the fuljes described by me in the *Geographical Journal*, March, 1897, January, 1900, and August, 1901, but turned the other way round, *i.e.* the steeper slope is exposed to, instead of being turned from, the wind. When the wind has cut right through along the line of the original notches or re-entrants, the residual hillocks sometimes have a form which is related to, though not identical with, that of a barchan (Fig. 21).

To watch the wind-born detritus cutting away the snow-rock on

the frozen prairie is an education in the processes of Æolian erosion and denudation. Knowledge can be thus obtained not only more quickly than with harder rocks, but in some respects more completely, for it is easier to discriminate between the transition forms and those which are more stable.

Ripplings, which Heim calls *Schmeltzwellen*, are also produced when snow melts under the influence of a warm wind.

I measured a group of eight of these, which averaged 3·3 inches in wave-length, with a variation of 17·9 per cent.

The best exhibition which I saw was on February 14, when a *chinook* wind with a temperature of 42° Fahr. sprang up whilst I was out on the prairie at Moose Jaw, Assiniboia.

The relations of the waved surface formed by erosion of sticky

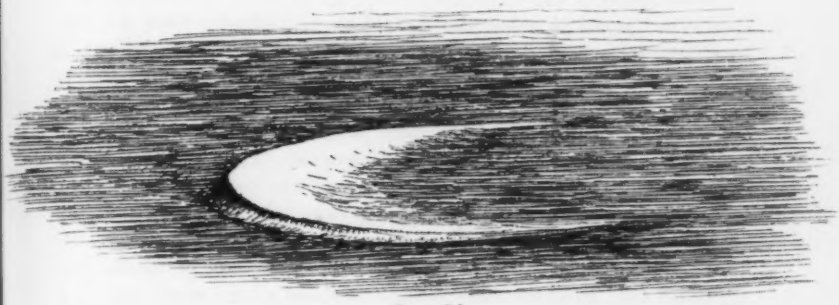


Fig. 21

Erosion form analagous to a Barchan, wind from the left, from a photograph.

or of compacted snow to normal snow-waves may be further explained as follows :—

As long as snow-flakes or granules adhere very little, wind not only shapes the surface into the form of waves, but makes the whole aggregate roll forward, so that the particles of the moving waves themselves move in a periodic manner, and the internal structure of the travelling waves, *i.e.* the arrangement of the particles of which they are composed, is due to the periodic movements of the material. When, however, the snow becomes conglomerate instead of loosely aggregate, so that the particles can only be removed in fragments—for they break sooner than part company with the neighbours to which they are attached—the course of affairs is different. Then, although the wind sometimes carves the surface into the form of waves, and although these forms move, yet the subjacent material does not move, and its structure is not wavy. Such scarped wave-surfaces might be called *kymatoids* or *kumatoids*.

It is common to see both scarped wave-surfaces and normal waves simultaneously, so that there are small cliffs of snow facing in opposite directions, one set reflecting the sun, and the other in shadow. At first the appearance of the snow-covered prairie when in this state seems hopelessly complicated, but it is not really so. When the mind has mastered the two sets of forms produced by wind in snow (or other powder), in the incoherent and coherent condition respectively, the eye soon detects an order among the inequalities of surface.

On the Snow-drifts caused by Inequalities of the Ground, or Other Fixed Obstructions.

Under this heading are treated the inequalities of snow-surface due to the action of fixed obstructions upon the wind.

Snow-fences of the form shown in Figs. 22 and 23 are commonly erected in Canada to check the rate of snow-drifting. After the first snowfall a snow bank or drift is produced, having a moderately gentle slope to windward and a cliff or talus on the lee side. The form resembles that of a sand-dune or any other wave of a drifted powder, which at first suggests that the form proper to a drift caused by the fence is similar to that of freely drifting snow. This, however, is not the case, for the structure is as yet incomplete, owing to insufficient supply of the material. Succeeding snowfalls build out the drift in the manner shown by the successive positions of the lee face in Fig. 24, until we have at last, perhaps not until nearly the end of winter, the completed form in which there is no lee cliff, but a long, gently tapering slope on the lee side, the weather face retaining its original form and *relatively* steep slope.

When we have to do with large bluffs or cliffs, the whole of the winter's snow is not sufficient to fill in the area of eddies on the sheltered side so as to reduce the surface to "easy lines." Thus the largest drifts are never of completed form, but have always a steep face to leeward. Completed drifts, having no shadow-throwing cliffs, are also much less conspicuous relatively to their size. Thus circumstances combine to prevent the casual observer from discovering what is the profile really proper to a snow-drift.

Fig. 25 is drawn from a photograph of a snow-drift near Winnipeg, where one side was complete and the other incomplete. The consolidation of the snow between snowstorms accounts for drifts being formed on both sides of the railings.

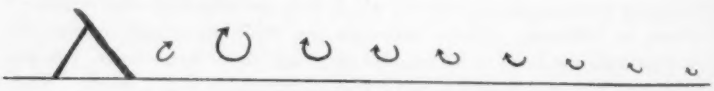


Fig. 22
Fence and system of Eddies.

The great length of the lee-slope in proportion to the height of a drift explains at once how obstructions tend, on the whole, to produce longitudinal drifts in place of the transverse ridges which arise where snow drifts freely in sufficient quantity. It is evident that unless the breadth of the obstacle be many times greater than its height, the

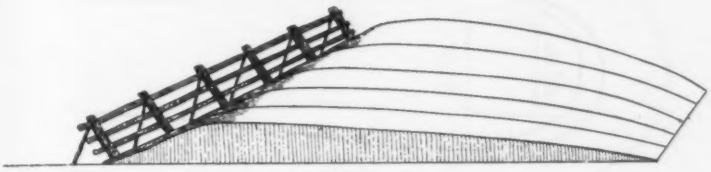


Fig. 23
Fence and completed snow drift.

principal extension of the completed drift must be longitudinal, not transverse. This should be noted by those who may still cherish the notion that the waves in sand or snow are usually produced by obstructions.

The ground plan of the principal snow-drift caused by a house on

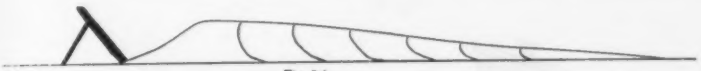


Fig. 24
Fence and snow drift showing stages of its growth.

the prairie near Winnipeg is that of an elongated horseshoe. Not only is the ground swept clear by the wind near the corners of the building, but there is a long stretch to leeward between the two arms, or horns, of the drift which is kept clear, or nearly clear, of snow, and which, I

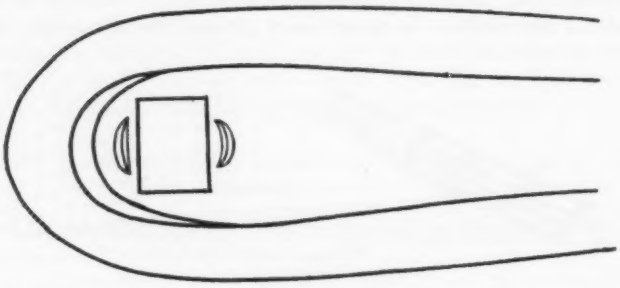
Fig 25
Snow drift on both sides of a fence, on the right completed, on the left incomplete, from a photograph.

think, sometimes extends further than the drift can be traced. It is easy to recognize the relation of the form of these fixed banks to that of the barchan or medaño of freely drifting snow (Figs. 26, 27, 28, 29, 30, and 31).

The form of the excavation round trees, observed very frequently

in woods near Montreal, calls for remark (Figs. 32, 33, 34, and 35). Here the snow lay deeper and drifted less than near Winnipeg. As the

Fig 26

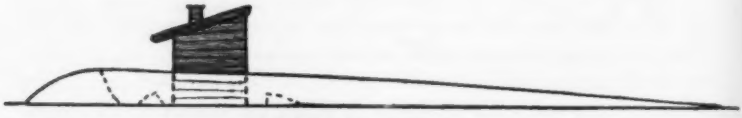


PLAN

of the principal snow drift around a house on the prairie, near Winnipeg, wind from the left.

drifts above described are analogous to barchans or medaños, so these hollows are analogous to fuljes. What requires explanation is the

Fig. 27



PROFILE

Central longitudinal section of same snow-drift.

circumstance that in this case the influence of the obstruction does not appear to extend beyond the cliff top, and that there is nothing corre-

Fig. 28

Transverse section of snow drift on lee side of an outhouse on the prairie.

sponding to the outer, windward slope of the prairie drifts. I think this is due to the circumstance that air in flowing over a thick bed of

loose, soft snow is not thereby thrown into such strong upward whirls as in flowing over a rough and rigid surface.*

Under circumstances when larger trees have a space round them clear of snow, saplings have none, even though they be large enough to

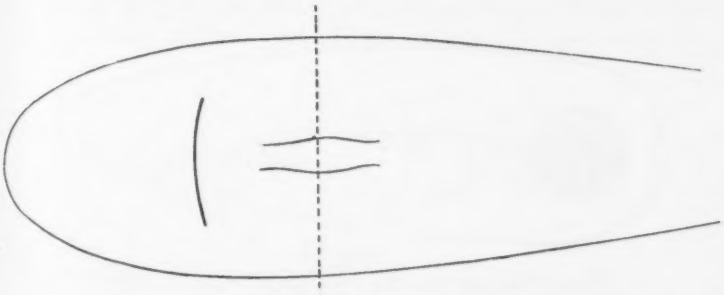


Fig. 29

Plan of snow drift caused by clump of bushes, wind from the left.

be practically rigid. This is presumably because the smaller obstacle does not cause so strong a vortex.

On both sides of a wooden wall the snow ultimately banks up, so as

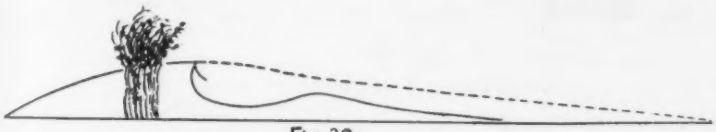


Fig. 30

Profile (dotted) and central longitudinal section of the same drift

to leave only 2 or 3 inches clear at the top. At the ends of the wall the ground is swept clear of snow, except in the event of a fall of sticky snow plugging the holes and subsequently "setting." The excavations

Fig. 31

Section across the dotted line of Fig 29.

at the ends, if brought together, reproduce the hollow which is seen round trees and such narrow obstructions. In the centre of the bank

* Determinations on six days gave 2·2 miles per hour as the rate of subsidence of snowflakes. Where the slope of the ground gives an upward velocity of about this amount to the air, the snowflakes are presumably maintained in eddying suspension. Thus the slow rate of subsidence explains the marked effect upon the depth of the snow-deposit, which is exercised even by gentle undulations in the ground, which have such "easy lines" that they cannot give rise to strong eddies.

on the windward side of the obstruction in the latter case is an inflexion of the curve in plan, shown in Fig. 36, at the spot where there is presumably no lateral current of air.

On widening out the obstruction, this central projection becomes the bank on the windward side of the wall. Here the wind eddies round

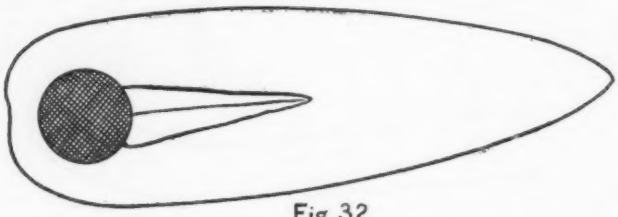


Fig. 32

Plan of hollow round a tree, wind from the left.

Fig. 33

Longitudinal section of the same.

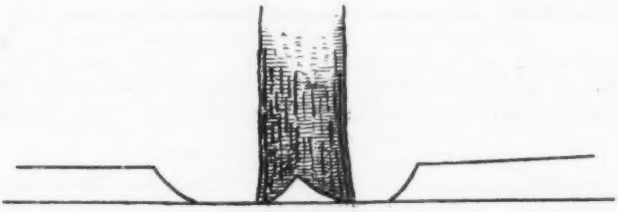


Fig. 34

Cross section of the same. lee side.

and round in a repeating circle, so that, I suppose, gravity has time to exert its effect and brings the snow down. The clearance near the ends of the wall is where the path of the air, as I suppose, is something like an open spiral, in which the drifting snow follows a continuous, not a re-entrant, course. The spiral is right-handed at one end of the wall, and left-handed at the other.

Under this heading I must refer to the behaviour of the drifting snow with relation to the whole city of Winnipeg, considered as one obstruction upon the level surface of the prairie. When the wind was strong, the sky free from ordinary cloud, and the temperature at or below zero Fahrenheit, the air in the streets usually remained clear and almost free from snow, although the sun was dimmed by something like a dust-cloud, and halos and parhelia indicated the presence of icy

Fig. 35

Hollow cut by wind, from left, around a heap of manure on a field, from a photograph.

particles in the air.* As one approached the limits of the city, however, and looked out upon the open prairie, one saw a very different state of things. The snow was drifting so thickly near the ground that nothing could be distinguished through it, and only the upper parts of houses on the prairie stood out fairly clearly from the whirling white haze, which produced an effect not unlike that of spoon-drift in a storm at sea. How, then, are we to explain the clearness of the air in the streets?

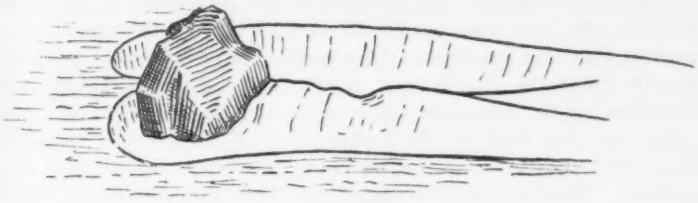


Fig. 36

Hollow etc cut by wind, from left, around a stone from a photograph taken in Scotland February 1900.

Either the drifting snow got past the city, or it did not. If not, there must have been enormous snow-banks produced on the windward side, whereas the drifts there were not really of great size; on the other hand, there was much snow on the more sheltered side of the city, in the woods, etc. It appears, therefore, that great part of the drifting snow got past the city, so that the question which remains to be answered is—Did it go round, or was it wafted over? Winnipeg is an

* See Appendix, "Sun Pillars."

exceptionally widespread city of about fifty thousand inhabitants, so that the height of the houses is very small in comparison with the width of the town. Having examined the snow-drifts in the suburbs, and noted their absence from the streets, I came to the conclusion that a great part of the drifting snow was wafted quite over the city.

On the Relation between Surface Waves in Water and in Powders.*

At sea the water is always rising in front of the crest of each advancing wave, and sinking behind it. When the wind blows over these ridges it goes into eddies on the lee side, and the pressure is less there than on the weather slope of the wave. This difference of *pressures* maintains and increases the height of the wave. The liquid flows under the action of gravity from places of more to places of less atmospheric pressure, and this is by far the greater part of the mechanism by which wind maintains and increases the waves of the sea. The process is abetted by the readiness with which wind adopts a sinuous form of flow. There is also an auxiliary, but, in the case of water-waves, distinctly subordinate, process in the wave-making due to the friction of the wind upon the surface of the water (capillarity may be neglected in the case of the larger waves which we are considering). This friction tends to drive the water-particles near the surface towards the crest of the wave, pushing them forward on the weather slope, and dragging them backward in the eddy on the lee side.

In the maintenance and increase of the corresponding waves in powders, we have first, as in the case of liquids, the predisposing condition in the tendency of the wind, upon very slight provocation, to adopt the sinuous flow. There is also the same distribution of eddies, with difference of pressure on the two sides of each ridge, and the flow of the bottom layer of air towards the ridge from both sides, with an accompanying prehensile action upon the surface. The relative importance of these two factors of wave-making is, however, reversed. A powder does not undulate as a liquid by the transmission of gravitational pressure It does flow under the action of gravity to a limited extent, viz. until its slopes are reduced to the angle of repose characteristic of the material, which for dry sand is about 30°. On the other hand, a brushing of the surface much more readily separates the surface particles of a loose powder than those of a liquid from their subjacent neighbours, so that the frictional transport

* I employ this word to indicate the condition of the body without reference to its mode of production. (This paper was written before the reading—February 13, 1902—of Prof. Osborne Reynolds' paper "On the Sub-mechanics of the Universe" (*Abstract Proc. Roy. Soc.*, vol. lxix. No. 457, March 21, 1902), otherwise I might perhaps have used the term "granular medium" instead of "powder.")

from both sides towards the ridges is much greater in the case of a powder than in that of a liquid. Consequently, the filling of the eddy spaces on the lee of the ridges is brought about differently in the case of the travelling waves of water and of powders respectively. In a powder the material which collects against the lee face of the ridge, causing it to advance, is gathered from the surface layers—that is, from no appreciable depth; but the horizontal distance from which the particles are brought to the shelter of the ridge is a whole wave-length. In deep-sea waves, on the other hand, the excursion of the particles which fill up the eddy space and produce the advance of the ridge is small. In steep waves the particles which travel furthest only move about one-eighteenth wave-length horizontally, but the depth to which the movement appreciably extends is a large fraction, say one-half of the wave-length. The amount of motion of water due to pressure, and tending to equalize differences of pressure, is so much greater than the amount due to dragging towards the crest by friction, that sea-waves are, in the deep, of not very different steepness on the weather and the lee side respectively. In the case of powders which cannot so adjust themselves to atmospheric pressure, the waves soon acquire, and thereafter maintain, a great difference of slope on the two faces.

On the "Ichthyomorphic" Character of Stationary Snow-drifts and their Relation to Travelling Snow-drifts.

The study of sand-drifting and snow-drifting largely consists in observing the form and position of eddy spaces, and the manner in which they are filled by the transport and deposition of the particles which the current of air or water removes from the surface of the powder. From an examination of the snow-drifts in Canada, I came to the conclusion that a curve of the character shown in Fig. 37,* with the blunt end towards the wind, was the fundamental element of their form.

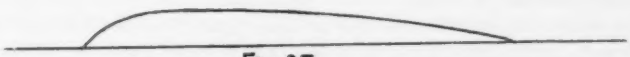


Fig. 37
The fundamental curve of snow drifts.

This, which I may term the *ichthyoid curve*, is the profile of *completed* drifts in the neighbourhood of obstructions on the prairie.

Inverted, it is the profile of the holes round trees, as observed in the woods near Montreal.

Viewed in plan, it is the curve cut out in the snow round the end of a wall.

* These curves are, for convenience, drawn with the vertical dimension exaggerated.

Viewed in plan together with its image, it is a boundary curve enclosing the horseshoe-shaped banks round houses near Winnipeg, and equally the hollows round trees or stones.

This doubled curve has the generalized form of a fish * (Fig. 38), or if it be spun round so as to give the outline of a solid body, we have the modern Whitehead torpedo with the blunter head now preferred to the older sharp-nosed form.

Fig. 38
The same doubled.

The analogy to the fish-form is still more striking if we look at fishes from above instead of viewing them in profile.

The doubled curve is, again, that of the fore-and-aft section of the propeller-shaft struts, or "A frame," as approved by the Admiralty. These projections from the ship have to be constructed so as to give as little resistance as possible. Being wholly submerged, the most important point is that they should have a form which shall cause as little eddying as possible. Prof. Hele Shaw, F.R.S., has shown that if they be turned round so that the sharper end becomes the fore part, the eddy-making is considerably increased.† I had not this or other kindred facts before me when I worked out the generalized curve for snow-drifts, and was quite unbiassed by such considerations in my selection.

When the snow is drifting, one can see that it whirls in the largest circle not far from the obstruction, that there is whirling motion for a long distance to leeward and for a relatively short distance to windward. I regard the completed snow-drift in the neighbourhood of an obstruction as a filling in of the eddy-space in such a way as to provide easy lines for the flow of the wind.

I suggest that the forms of such drifts are worthy of study as an index of forms of least eddying resistance. They suffer, it is true, from the disadvantage of being situated on the floor over which the current flows, and so far are less valuable in this regard than the forms of fish, cetaceans, birds, and flying insects. On the other hand, the animated forms have to fulfil other functions besides those of progression, and are possibly a compromise.

It will not have escaped the notice of the reader that in waves into which freely drifting powders fall, the steep side is on the leeward instead of upon the windward, and that this signifies that the eddy-space is *never* filled up. The whole eddy-space is, in fact, free to move

* The profile of the snow-drift resembles the profile of a sole or other flat fish.

† *Vide* "Experiments on Surface Resistance of Water," *Engineering*, vol. lxv April 22, 1898. Figs. 39 and 40 of that paper confirm the dictum of the late Mr. William Froude that "it is blunt tails rather than blunt noses that cause eddies." See also *Movement* by E. J. Marey (trans. E. Pritchard), 1895, p 97.

forward, and does so when the snow is drifting, and this progression is the wave motion.

The relation between the profile of the snow-drift and that of the waves of drifting snow and sand may be further illustrated by drawing the profile of the wave, not in the usual way, from trough to trough (Fig. 39), but from crest to crest (Fig. 40). We then see that the unfilled space between the two ridges has the blunt nose and fine tail profile; that it is the profile of the hollows in snow round trees and of the fuljes of sandy deserts, the form proper to an eddy space.

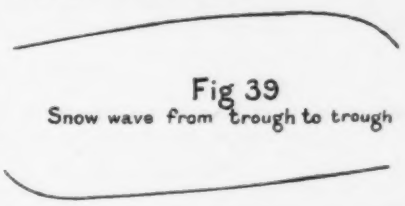


Fig 39
Snow wave from trough to trough

Fig. 40
The same from crest to crest

I repeat that the powder, when drifting in waves, has the "fine nose and blunt tail form," which is that of greater eddy-making resistance (the nose being that part turned towards the wind), and that the powder, when in its complete accumulation near fixed obstructions, assumes the "blunt nose and fine tail" form, which is that of less eddy-making resistance. Both forms are simultaneously produced on a snow-field, and both are compatible with the removal by the wind of the maximum quantity of snow in the course of the winter. Thus, on the one hand, the maintenance of strong eddies in the drifting waves evidently increases the power of the wind to drive the snow before it; and the hindrance offered by a fixed obstruction is best minimized by filling in its eddy-space with a structure which shall thereafter absorb as little energy from the wind as possible.

Sometimes, as we have seen, the freely drifting snow is accumulated in isolated hillocks, which I have called barchans or medaños. Sometimes their development from patches of drift snow can be observed. These patches have in ground plan a fine nose towards the wind, and a blunt tail or lee end—a sort of delta shape, but with curved sides (Fig. 14). I have seen the same thing in sand. This is in accordance with the habit of the freely drifting snow to adopt a fine nose and blunt tail arrangement in vertical profile.

Freely moving barchans of less or greater elongation probably fill in less or more of the narrow end of the ichthyoid curve. The crest of the cliff will be lower than the summit of the barchan if the former be beyond the broadest part of the curve.

As the easy lines of completed snow-drifts, with their bluff breast and tapering stern, resemble the body forms of cetaceans, fish, and birds, so also the cornices of incomplete snow-drifts and the cusps of barchans in snow or sand resemble some structures which are required

to grip the fluid through which they move. They resemble, for instance, the arch of the wing which is so well developed in the heavier birds, assisting them to rise. In like manner the cusp of the incomplete snow or sand drift, by maintaining the eddy, enables the wind to collect the drifting material quickly on the lee side.

My friend Mr. E. A. Malan suggests that the bifurcating drifts, such as that in Fig. 36, which occur also in sand, not only recall the form, but also illustrate the steering function, of forked tails of the swallows and other birds.

APPENDIX.

ABSTRACT OF PAPER READ BEFORE SECTION E (GEOGRAPHY), AT THE MEETING OF THE BRITISH ASSOCIATION IN BRADFORD, SEPTEMBER, 1900.

On Snow-ripples, etc., in Scotland.

These observations were made in Scotland, in February, 1900. The general conditions during the following observations are: ground already covered with snow, temperature a little below the freezing-point.

Case I.—Snow falling sparsely. In absence of wind the surface was uneven, owing to clinging together of flakes. In a light breeze there was a notable tendency for the prominent parts to arrange themselves in ridges, the distance from ridge to ridge not more than 1 inch. When the breeze freshened these became regular ripples, with a smoothed surface of closer texture. One set of measurements gave the distance between successive ridges, 1·125, 1·225, 0·85, 1·05, and 1·00 inch (average 1·05). Their amplitude was approximately 0·05 inch, which gives a ratio length : height = 21 approximately. The steep face of these ripples is on the windward side, whereas in sand-ripples the steep face is on the sheltered side. The normal movement is downwind, the most noticeable feature of the process being the retreat of the steep weather-face, consequent upon the abrasion of its surface. For occasional short intervals, however, *during lulls and during moments of heavier snowfall, the ripples rush upwind*, owing to the sudden deposit of snow upon each weather face.

Case II.—Fresh breeze without snowfall, blowing upon uncompacted snow. The surface was beautifully covered by ripples of 3 inches to 15 inches from ridge to ridge, which were rapidly increasing in size. The steep side faced the wind. The ridges, which were pretty accurately parallel to one another, were transverse to the wind, but with much sinuosity, no ridge being straight for more than a few inches. It is evident that the wind must be concentrated in the re-entrant angles of the steep weather slope, and this would tend by rapid erosion to destroy the arrangement of long transverse lines, which is the most obvious characteristic of ripples. The ridges, however, did not lose their transversality, which was apparently preserved by the greater deposit of drifting snow in these re-entrants, which stopped the threatened gaps; and by the collapse of the overhanging cornice of snow at the salient angles, by which these promontories were truncated.

Case III.—The latest-fallen layers of snow having been blown away, the wind acts upon compacted snow (this was generally in drifts which had become exposed owing to change of direction of wind). The wind abraded a fine granular "drift," which did not adhere to the smooth hard surfaces. Parallel lines of bevelling or

grooving transverse to the wind are the most conspicuous feature of the resulting structure in the compact, almost homogeneous, fine-grained material. The lines are much freer from minor irregularities than the ripples described above. As the action continues, however, the sinuosities are emphasized, for, the drifting snow not adhering well, the re-entrants are cut back more and more behind the salients. Further, the wind concentrating along the lines of the re-entrants, the general level of the surface there is lowered more quickly by abrasion than is the case along the intermediate lines of the salient angles. Thus is produced an intermediate form in which the transverse ridges are crossed at right angles by alternate ridges and furrows parallel to the wind, the furrows being along the line of the re-entrants.

This action went on until the ridges transverse to the wind were merely a subordinate and scarcely noticeable feature, and the snow was seen to be in great ridges parallel to the wind.

Sun Pillars.

A letter by the Author in "Nature," April 17, 1902 (vol. 65).

On January 19, 1901, during zero weather at Winnipeg, Manitoba, the fine icy particles which floated over the city as a cloud at 11 a.m. gave a halo round the sun with two mock suns, to the right and left, at the same altitude as the sun, and above the halo an inverted arc of about 120° showing prismatic colours. There was a good deal of wind at the time.

At night the wind dropped and the air became very still. The haze of icy particles descended, and in the middle of the night its illumination by the strong arc lamps of the city gave a column of light, comparable to a sun pillar, extending above each lamp to a height estimated at 300 feet. A striking feature of the phenomenon was the perspective effect, the columns diminishing in apparent height in such precise proportion to the increasing distances of the street lamps that it was evident the upper surface of the cloud of particles was truly horizontal. At this time the vertical columns of light were also visible below the lamps and extended to within a few feet of the ground. A few hours later, viz. at 4 a.m., January 20, the lower ends of the columns were more than 60 feet from the ground, and therefore far above the lamps. They extended to a height of about 300 feet, as judged by the distance of the nearest lamp and my elevation above the ground, which was about 60 feet. A narrow rift extended horizontally through the cloud, breaking each column of light into two parts. The figure is re-drawn from a rough sketch made at this time of the columns above three, only, of the numerous arc lamps.

The slight haze of minute icy particles which is common in zero weather is, I believe, called *poudrette* in Eastern Canada.

Before the reading of the paper, the President said: This evening we are to have a very interesting paper by Dr. Vaughan Cornish, "On the Snow-waves and

Snow-drifts in Canada." I now call upon Dr. Vaughan Cornish to read his paper.

After the reading of the paper, Prof. NORMAN COLLIE said: I am afraid I have very little to say on the subject of waves. But I can say a little about this country of Canada which Mr. Vaughan Cornish has travelled through in the depth of winter. I have not seen it under those conditions; I have only seen it when it has been under the hot sun of summer. Then the prairies were not covered with snow, but with grass, and there was no snow in the valleys, but only on the mountain-tops. Still, I think it says a great deal for the energy and perseverance of the Canadian Pacific Railway to run its trains every day through such a country, where the snow is sometimes 5, 10, 15 or 20 feet deep. The Canadian Rockies, where some of these beautiful photographs were taken, is going to be, I feel certain, the Switzerland of North America. It is a country which abounds in the most beautiful scenery, not only of magnificent rivers and pine woods, but there are glaciers and snow-peaks as well, and there is perfectly healthy air, where the people of the United States and Canada can go for their holidays in the summer-time. The pine woods then are not filled with snow, but with mosquitoes, especially during July and part of August, but in the latter part of August these mosquitoes go. In some respects the Canadian Rockies are very similar to parts of Switzerland, but the magnificent pine woods and splendid rivers are far finer than one gets in Switzerland; there are also beautiful lakes filled with trout, and snow-peaks, glaciers, and mountains. It is a country which, I have no doubt, will very soon be opened out and made into one of the playgrounds of North America. I am afraid I can add nothing on the subject of waves or drifting snow, because in summer-time, when I have been there, even right up on the mountains where there is perpetual snow in the summer-time, the snow is rapidly melting, and so one does not get any of these wave-forms. I am sure you will agree with me that these photographs we have seen to-night are revelations of the different forms snow can take up. One often notices these forms. Last Easter I was in Scotland, and the snow was many feet deep—in fact, about Easter there is more snow on the mountains than at any other time of the year, and in the drifts and on the tops of the hills one often sees these wave-like forms. One looks at them, passes them by and takes no notice, but after what we have seen to-night I think that the next time we see drifted snow we shall look at it with very much more interest, and, seeing the many curious formations, will understand how it is that the many marvellously beautiful curves are formed.

The PRESIDENT: I am sure we have all listened with great interest to this paper, which is one of a series that has been communicated to us by Dr. Vaughan Cornish. I have been struck, and I think we all must have been struck, with the great care and patience with which he has made these researches, and also with the acuteness of his observations. The scientific investigations, purely scientific investigations, he has made are of course of great importance, and as his paper proceeded, and as we listened to his former papers, I am sure we must all have felt that these purely scientific investigations would lead to useful and practical results in various ways. With regard to the snow-ripples, there is the well-known practice described by Baron Wrangell in Siberia, by which travellers in that vast region were able to steer when the sky was overclouded, by knowing the prevailing wind and understanding the forms which its influence caused to be taken on the ripples of the snow. He also relates how, when there have been light falls or drifts of snow in other directions, travellers would get out of their sledges and by sweeping away the upper surface of the snow, would reach the harder or permanent ripples. That is one way in which the knowledge of snow-ripples has been turned to a very practical use. Dr. Vaughan Cornish was showing me in the

other room some of his photographs, which were examples of the way in which, by a knowledge of the formation of ripples in sand, one would be able to tell the direction of currents in mouths of rivers and estuaries. So I think we can congratulate Dr. Vaughan Cornish, not only on the great scientific value of his investigations, but also on the practical use to which many of them may be turned. I now ask the meeting to pass a unanimous vote of thanks to Dr. Vaughan Cornish for his valuable paper and for the beautiful way in which he has illustrated it by his photographs.

THROUGH THE GREAT CAÑON OF THE EUPHRATES RIVER.*

By ELLSWORTH HUNTINGTON.

A REFERENCE to the map of Asia Minor shows that the Euphrates river is formed by the union of two great branches. These for several hundred miles flow west-south-west in nearly parallel longitudinal valleys bounded by high ridges of mountains. The north-western branch, or Kara Su, although it is smaller than the other, is generally called the Frat, or Euphrates. Near Egin the mountains that bound its valley come together, and it is obliged to turn abruptly at right angles toward the south through a tremendous gorge, which it has cut directly across the southern range of the anti-Taurus mountains. Twenty miles below the gorge it empties into the larger branch, the Murad Su. The latter flows from north of Van nearly straight west-south-west to this point, part of the way through an unexplored cañon, said to be longitudinal and impassable. Below the junction of the Murad Su and Kara Su the Euphrates river makes a great bend to the south, and later to the east, and then, again turning south, zigzags through the Taurus mountains in a deep gorge. It is this great bend and the lower part of the two branches which I propose to describe.

Before proceeding to that, however, it will be well to get a general idea of the physical features of the surrounding country. We will examine these in geographical order, beginning on the south with the Taurus range. This rises here to an average height of 7000 feet, the lowest passes, except where the Euphrates and Tigris rivers cut through the range, having an elevation of about 5000 feet. The core of the mountains consists of a very old trap, the oldest formation of the region. This is broken in many places by eruptive granites and porphyries, which are older than the oldest stratified deposits. These crystallines are especially abundant on the north side of the mountains. On the weathered surface of these igneous formations are the remnants of a complex series of strata with several unconformities marking intervals of erosion so extensive that

* Map, p. 177.

only the upper series of strata remain in large quantities. These are Cretaceous shale and limestone containing, among other fossils, numerous hippurites and nummulites. In post-Cretaceous times extensive elevation and mountain-building took place accompanied by considerable faulting. Probably it was at this time that the shale was locally much metamorphosed. The Cretaceous strata, rarely exceeding 1000 feet in thickness, form the tops of the majority of the mountains. Overlying the uplifted and highly eroded surface of this formation are numerous recent lava-flows, chiefly basaltic, which evidently took place after the country had assumed approximately its present topography. In several places there are cones of ash, and south of Lake Gyuljuk there is a crater enclosing a pond.

This lake lies in a longitudinal valley between the northern ridges of the Taurus, in the neck of the great bend of the Euphrates river. Its position in respect to the latter is so remarkable that it deserves notice. The map shows that below Palu the river flows southwest directly toward the lake and in the same longitudinal valley. Fifteen miles from Gyuljuk it is turned west and north around the great bend already mentioned. After a course of 160 miles, it again enters the same great valley on the opposite side of the lake, toward which it once more flows, this time in a north-easterly direction, to a point 15 miles from the lake, where it turns south. The valley, which is everywhere a prominent feature in the topography, is occupied by six small streams beside the lake and the river, three flowing west and three east, two to the lake and four to the river; and in it, moreover, is the service of the main branch of the Tigris river.

The name Gyuljuk means "little lake," but the sheet of water is 12 miles long and from 2 to 3 miles wide. Previous to 1878 or 1879 it had no visible outlet.* For many years its borax-bearing waters had been steadily rising, and at that time overflowed to the Tigris. The older villagers, who live along the shores of the lake, say that they can remember a time when the water was 20 or 30 feet lower than it now is. Their fathers told them that in their young days it was possible to wade to an island which is now separated from the shore by water 75 feet deep. They had heard that still earlier the island was connected with the mainland, and was the site of the village which now lies on the mainland opposite. This is incontestably corroborated by the fact that on the island are the remains of an old monastery,† all around which may be seen the ruins of houses submerged in the lake to a depth of 25 or 30 feet. Part of the stones of the monastery are of a kind not now found

* H. F. Tozer, 'Turkish Armenia and Eastern Asia Minor.' London, 1881, pp. 239–246.

† *Verhandlungen der Berliner anthropologischen Gesellschaft*, February 17, 1900, pp. 144, 150–152.

4½"

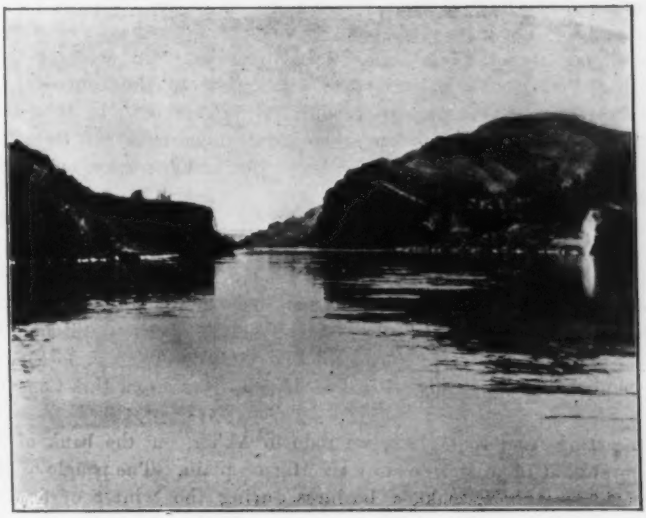
ERZINJAN
Kemakh
Kara Su
Muzur D.
Owajuk Plain
Zell Baba D.
Sugul Luis
Gyul D.
7000
Diyarbakir
Vakshen
Baghin
Peri Su
Sogetli
Kala
Tokma Su
Eski Malatia
Malatia
Arghani
Tigris R.
Mamush Chai
Omrun
Kopit D.
Bibol
Petterge
Gyaza
Kizilchahuk Chai
Hasan Badrik
Sheikh Hassan
Orduzi
Ziaret D.
Chemmug
Hazar
Gechud C.
LAKE GYULJUK
Scale of Miles
Nat. scale 1:375,000
Castle
Gyuljuk
Crater Pond
The Great Cañon
of the
EUPHRATES RIVER
By Ellsworth Huntington
Scale of Miles
Nat. scale 1:1,500,000 or 23·7 miles = 1 inch
Heights in feet. Routes

in the vicinity, but probably cropping out under the lake. Some villagers who know how to read say that in their church was an old book, unfortunately destroyed during the events of 1895, in which it was recorded that six hundred years ago the site of the lake was a plain, through the middle of which flowed a stream emptying into a hole at the lower end. This hole was later filled with silt, and the stream was thus dammed so as to form a lake. In 1899 I mapped the lake and took a number of soundings, from which the contour of the bottom was roughly determined. It is perhaps worth noting that at the east end, just where the villagers locate the ancient outlet, there is a very precipitous slope with a descent of 400 feet in 1100 feet. Another corroborative piece of evidence is furnished by two castles which were built between one and two thousand years ago, and stand on opposite sides of the lake, near the middle. Such castles are always built with a definite purpose, but under the present circumstances it is hard to imagine what use they could serve, as there is nothing for them to defend. If there were no lake, the shortest and easiest road from Harput to Diarbeker, as determined by the location of passes, would go directly across the lake-basin from one castle to the other. Hence they lend additional certainty to our conclusion that no lake, or only a very small lake, existed here one or two thousand years ago.

Accepting this conclusion, it is clear that the present shore-line is along an old beach. In twenty or twenty-five years a small lake like Gyuljuk would be utterly unable to have much effect in producing a bench along its margin. The beach as now seen, however, consisting of sand and pebbles, is fairly continuous, although broken in many places by projecting cliffs, especially on the north side, where the shale dips away from the lake; and in some parts the beach is 40 or 50 feet wide, and is backed by a second line of wave-worn material lying 6 or 8 feet above the lake-level, which has been lowered by a trench dug twenty years ago at the outlet. Behind this upper beach are several small lagoons. While discussing the beach, it may be said that all the little brooks which enter the lake have fan deltas of coarse pebbles and boulders. A few of the deltas are nearly 1000 feet wide. The condition of the shore shows that this is not the first time that the lake has stood at the present level. Accordingly we conclude that in prehistoric times the lake was the same size as now. Somehow it was drained wholly, or in large measure, and so in early historic times a plain occupied most of the present lake-bed. At last, less than a thousand years ago, the lake-basin began to be filled, and in 1878 the water overflowed into the Tigris river. The traditional cause for this emptying and filling seems the only adequate one. Violent or extensive earth-movements are utterly out of the question, because there is not the slightest sign of them, the present shore-line agreeing exactly with the

old one. Changes in climate are impossible as an explanation, because a reduction in rainfall sufficient to cause the lake to shrink to the size which it must have assumed, would have made the surrounding country a desert at the beginning of our era, which, as every one knows, is contrary to the facts of history. Therefore we seem to be justified in assuming that somehow a passage was opened in the bottom of the lake; most of the water was drained off; later the hole was filled, probably by the deposition of silt, and so the lake was restored to its former condition.

North of the Taurus mountains is a great lozenge-shaped basin, from the two ends of which flow the Murad Su and Tokma Su in opposite



A RUINED BRIDGE OVER THE MUZUR SU, NEAR MAZZERD.

directions towards the centre. This is floored with a series of plains formed of a fine alluvial deposit and broken by a number of small mountain ridges. Cretaceous strata are abundant in these ridges, but their lower layers contain more sandstone and conglomerate than do the corresponding strata further south. North of the plains lies the southern half of the anti-Taurus mountains, in which may be included the great Dersim range. The old trap, the Cretaceous strata, and the later lava-flows are well represented, and there is a large development of limestone, seemingly older than the Cretaceous, although its age has not been determined. This is especially abundant among the highest mountains, those around which the Kara Su flows, where it turns from

a westerly to a southerly course, and in the lower mountains farther west. It reaches its maximum development in Muzur Dagh, where the thickness from the river at Egin to the top of the mountain appears to be 8000 feet. Between the two great divisions of the anti-Taurus mountains lies another series of alluvial plains at an elevation of from 4000 to 6000 feet. They are to Asia Minor what Tibet is to Asia Major. Through them flow the Kara Su from the east and the Chalta Su from the west, meeting a few miles above Egin. The former flows on the surface of the larger plains, but on the sides of the latter river the plains lie at a much higher elevation, and have been cut by the river to a depth of 2000 feet.

Such, in brief, is the country where the Euphrates is formed by the junction of two large streams, and changes its course from eastward to southward. The main roads have been often traversed and described by travellers, but most of the region is very imperfectly known. The great general Von Moltke was the first to investigate the course of the Euphrates river, as it zigzags through the mountains.* In July, 1838, when the water was at its lowest, he floated down on a raft from Palu to Birejik, finding the first 125 miles to Kemur Khan easy, but farther down, in the gorge through the Taurus mountains, meeting with the greatest difficulty because of rapids. A second attempt in the spring of the next year, when the water was high and the rapids more dangerous, had to be abandoned at Tilek near the beginning of the greatest cañon. Since that time no one, so far as I can learn, either native or foreigner, had attempted the journey through the lower gorge until in the spring of 1901 it was my good fortune to accomplish it in company with Prof. Thomas H. Norton, U.S. Consul at Harput.

Starting from that place, we rode to Akhor, on the bank of the Euphrates, at the eastern end of the Harput plain. The people of this village, Armenians, make a business during the winter of floating down the river to Kemur Khan on rafts of skins, fishing as they go. These rafts are known as kelleks, and the raftsmen as kellekjis. As there are no equivalent English words, I shall employ the Turkish terms. At Kemur Khan the kelleks are taken to pieces, and together with the fish loaded on donkeys sent by land across the neck of the river's bend to meet them. The fish are sold at Harput, and the rafts are taken back to the village, whence they start again. We had engaged two of these fishermen to take us down the river as far as we should choose to go, with the condition, imposed by them, that they should be allowed to make a portage around one dangerous rapid, of which they had heard, in the lower gorge below Kemur Khan. We

* See Moltke, H. von, 'Briefe über Zustände und Begebenheiten in der Türkei aus den Jahren 1835 bis 1839.' Berlin, 1876, pp. 289–291, 360–363.

sent our horses by land across the narrowest part of the bend of the river to Chunkush, and thence to Gerger, and on the morning of Friday, April 12, were ready to begin our voyage.

The making of the kellek took some time, although in the evening a number of entire sheepskins had been well soaked and left wet so that they might be pliable and ready for immediate use. In the morning they were inflated by blowing through the necks, the legs being securely tied so that no air could escape. At first the mouths of the blowers were at a distance of 8 or 10 inches from the necks of the skins, but as the latter became fuller and more difficult to inflate, the men's mouths were brought nearer until they touched the skins. When a hole was

KELLEK ON THE MURAD SU, NEAR ASHVAN.

discovered, it was quickly mended by putting a piece of wood like a checker against the inside of the hole and tying the skin firmly around it. A light frame of saplings was tied together with ropes, and under this were tied the skins, about thirty in number, with the legs up. They were packed together so closely as to make the kellek water-tight. Thirty skins seemed to us very few for five people, but the fishermen's rafts consist of only six, and two men sit on one such kellek. The kelleks always go in pairs on long fishing-trips.

As the spring of 1901 in Turkey was unusually dry, the river was comparatively low, being about halfway between the extremes of flood and low water. As it was, the current seemed very swift even in the

plain at Akhor. As soon as we began to float, we concluded that a kellek moves in the easiest, most delightful way that can be imagined. There is no jar or shake. The buoyant skins and pliant saplings adapt themselves to every movement of the waves. Half an hour after starting, we stopped for some time while the kellekjis gathered a great quantity of weeds, which they spread over the raft, partly to protect the skins from injury by our feet, but still more to prevent them from drying in the hot sun and cracking. Every hour or two they threw water over all exposed portions of the skins.

On the plain half a mile from this place, near the village of Elimellik, is one of the many artificial mounds which dot the plains of this region in large numbers, and which contain polished stone hammers, bone knives, and other implements. This mound is small, only 200 or 300 feet in diameter, and insignificant except for one thing. Close beside it flows a mill-race, which has undermined one side so that a perpendicular section is exposed about 30 feet high. About 12 feet above the level of the plain is a horizontal stratum of water-rolled gravel, 2 or 3 inches thick. Above and below this the mound is composed of loam filled with bits of pottery. Clearly this mound was built to a height of 12 feet, and then submerged under some body of water long enough for the layer of gravel, and probably for some layers of finer material, to be deposited. The water then retired, and men again occupied the mound. The cause of this submergence is not clear. The first thought is that it was due to a river flood of unusual height, but under present conditions this would be impossible, for the highest level of the water is now 30 feet below the mound, and the range from high to low water is not more than 15 feet. Moreover, if a flood reached to the mound it would not deposit gravel, but sand or finer material.

A short distance below this mound the river enters a gorge, and a series of small rapids is formed. It here turns north by west, and passes transversely through the small Harput range of mountains. The gorge, cut almost wholly in basalt, has walls 1500 feet high on the south side, and 2500 feet on the north, the distance between the two summits being but little more than 3 miles. Halfway between the entrance to the gorge and the mouth of the Muzur Su, an imposing basaltic rock rises in the middle of the river to a height of 60 feet. On the side down-stream, where alone it is possible to land, is an artificial platform, from which a flight of rock-hewn steps leads to the levelled top. A few other places where ascent might be possible have been protected by walls. On the right bank of the river close by is a cliff, in which has been cut a cave about 20 feet deep. From the back of this ascends a flight of seventeen steep steps, leading to an opening which commands a fine view up the river. The style of work shows that this was a fortress of the Haldis, or Näiri, those

unconquerable enemies of the Assyrians of whom we have lately learned so much through the labours of Drs. Belk and Lehmann, especially the latter. The location of a castle here, where there could be no bridge, and where the road along the river-bank is very difficult and much longer than over the mountains, and the fact that the watch-cave faces up, not down, the river, indicate that it was built to guard against enemies who came down the river itself. Probably they used to float down the river on kelleks 3000 years ago just as they do now.

LOOKING DOWN THE EUPHRATES FROM THE OLD MARBLE QUARRY NEAR KEBAN MADEN.

The next point of interest below the castle is the mouth of the Muzur river, a large and very swift stream with remarkably clear and cool water. Rising in the mountain-girt plain of Ovajuk, and fed by the springs of the great Dersim mountains, from the north side of which the snow never disappears, it always has a full stream navigable for kelleks from the plain to its mouth. Its largest branch, the Peri Su, 150 miles long, rises near Bingyul Dagh, south of Erzerum, and in spring is larger than the main stream. Thirty miles

above its mouth, near the old ruined town of Baghin,* with its Haldi fortress and two cuneiform inscriptions, it passes through a gorge on the two sides of which hot springs gush out in numerous places. For a quarter of a mile the river is confined between perpendicular walls covered with stalactites 40 or 50 feet long, the deposit of the springs.

Passing the mouth of the Muzur Su, we soon came to a ferry owned by one of the few beys, or feudal lords, whose power is still absolute. His Kizilbash retainers, a few days before our visit, had stolen the ferry-boat from Akhor, our raftsmen's village, in order to use it in ferrying wood to be sold in Harput. The mountains south of the river are wholly deforested and the Kurds are rapidly cutting the small growth that remains in Dersim. The men at the ferry got out their old flintlock guns and tried to force us to pay for floating past the place where they had the ferry rights, but our hats overawed them.

Below this the river leaves the mountains, but the valley is still hemmed in on the south for some miles by a wall from 500 to 800 feet high, capped with from 50 to 100 feet of basalt, the edge of a lava-flow which came from the mountains north-east of Harput and reached the edge of the river-valley, but apparently did not fill it. From here the river flows for 30 miles through low hills and plains broken only at Pertag. The first village passed on the right is Till, which must once have been an ecclesiastical centre of some importance, since there are the remains of seven Syrian churches, beside those of baths and houses. Indeed, the whole of Dersim is full of relics of the Christian population, Armenian and Syrian, that once filled it. At Pertag, close to Till on the same side, ruins of other kinds are found. From far up the river the picturesque castle is seen on its high pointed rocks. It was first built by the Haldi and last rebuilt by the Seljuk Turks, but no one knows by how many races it has been occupied between these extremes. At the base of the castle are the ruins of several mosques, churches, and baths, and of hundreds of houses. At the beginning of this century Pertag seems to have been a large and flourishing town, but in 1839–40 troops were brought here and quartered in the houses of the people, who promptly moved to their beautiful well-watered gardens, an hour away to the north-east at the base of the mountains. When the soldiers finally departed, the people did not care to return to their injured houses. Some ferrymen and a few zaptiehs, gens d'armes, are the only inhabitants of the old town. A fair is held here every Friday morning, and is attended by Christians and Mohammedans from all sides.

The river here cuts through a great boss of granite porphyry which rises in the sharp castle rock on one side and in a magnificent dark

* *Verhandlungen der Berliner anthropologischen Gesellschaft*, November 18, 1901, pp. 174–180.

cone, 1000 feet high, on the other. Along the river the rock forms fine though small columnar palisades. Just west of the castle, where the river leaves the palisades and enters a region of black basalt, we discovered the ruins of an old Roman bridge, which formed part of the road from Harput, through Kuttu Dere, in the midst of Dersim, to Erzinjan. This route *viâ* Erzinjan is the shortest from Harput to the Black Sea at Trebizond, but it is not now used, because the Kurds in the mountains through which it passes make travelling very unsafe. The makers of the bridge utilized as piers two islands, on the larger of which massive limestone blocks still remain in place. The rest of the way to the Kara Su the scenery is uninteresting, the open valley being cut through limestone, which forms low rounded hills a few miles back from the river. On the right bank one of the villages is Kogpenig, where many of the inhabitants live in caves. At Ashvan a model farm is being conducted on American principles under the direction of Prof. Norton.

The mouth of the Kara Su is disappointing because its appearance is not equal to its geographical importance. Both rivers flow slowly here, and approach each other from nearly opposite directions—a most peculiar configuration for well-established rivers of such size. In the summer of 1901, I floated down the Kara Su from Egin to the Malatia plain. The cañon at Egin is one of the finest in Turkey. Two miles above the town the narrow stream flows between solid walls of hard limestone 400 feet high, which even, when looked at from a distance, appear to be really perpendicular. Above these perpendicular walls the steep rough limestone rises 4000 feet on the west side in a distance of only 4 miles, and on the east side 8000 feet in scarcely 8 miles. Trees and vegetation are almost lacking, and the landscape is all brown and grey; yet, in spite of the bareness, it is grand. Egin itself, thanks to the great springs, is completely hidden in trees, so that the contrast between the green city and the bare mountains is most striking. In floating down the stream, the mountains are soon left behind, and the old limestone falls lower and lower, until at last it forms a wall but 10 feet high. Over this lie sandstone and much rough conglomerate, which seem to be a part of the great Cretaceous deposits. On both sides of the river the land rises 1000 feet or more in broad irregular terraces to a partly dissected plain covered with alluvium. Near the mouth of the Kara Su, the old limestone rises again in rounded hills from 400 to 1000 feet high. On the Kara Su below Erzinjan only one dangerous rapid occurs, 15 miles below Egin, and it is dangerous only because of the great number of stones in the middle of the channel. It is worthy of note, as an indication of the age of these streams, that, although the grade is in some parts steep, it is rarely broken by ledges and sudden descents. Except in the cañon between Kemur Khan and Chunkush, the rapids of both the Kara Su

and Murad Su are usually due to accumulations of gravel brought in by side streams.

The mouth of the Kara Su lies at the head of a second winding transverse gorge cut through limestone except at Geban Maden, where there is an outcrop of trap in which are silver mines. The raftsmen told us that 2 miles above Maden there were traces of another bridge, which, however, proved to be a quarry with a series of flat steps full of drill-holes, and cut into the face of the steep cliff in such a way that blocks of the beautiful variegated marble could be loaded on to rafts with the greatest ease. Where the marble was carried is not evident, as none of it has been noted in neighbouring ruins. The passage through the real gorge, beginning at Maden, occupies four hours with a swift current, and in spring some good rapids, which are scarcely noticeable in the lower water of summer. The limestone walls tower very steeply 1000 feet or more, and above that height the mountains rise another 1000 or 2000 feet. Hundreds of pinnacles and peaks rise like countless castles separated by gigantic clefts. Here a little tributary comes at the same level through a cañon with perpendicular walls; there a sheer cliff rises 500 feet; close by, the massive strata are crumpled like paper or are set at various angles by great faults. Where the strata are horizontal, the wall is benched with terraces from 20 to 60 feet high, each bearing on its top a strip of beautiful green grass in delightful contrast to the prevailing buff grey of the mountains and intense blue of the sky. Almost the only inhabitants are big-horned ibex and wild blue pigeons, which make their home in the numberless inaccessible caves which honeycomb the limestone from top to bottom. In the intense heat of summer, when everything dries up and the cañon is like a furnace, even these are not seen. Near the lower or south-west end of the gorge the walls grow steeper as they decrease in height, until the river passes out into the Malatia plain from between perpendicular limestone walls, here only 40 or 50 feet high.

The Euphrates, now turning south, skirts the base of the western extension of the Harput mountains, entering but slightly the great Malatia plain which stretches 20 miles to the west. The inhabitants on both sides are for the most part Kurds, those on the left of the river being largely Zaza, those on the right, north of the Kuru Chai (*Chai* = brook), being Kizilbash, and those on the right, south of the Tokma Su, Kurman; while the area between the Kuru Chai and the Tokma Su, very fertile, but not easily irrigated, is practically uninhabited. The Kizilbash are the most interesting of these three divisions of the Kurds. They are a mixed race, the foundation being some tribes of a stock allied to the Persians, who advanced into Turkey along the central highlands. These mountains were inhabited by Armenian Christians, who under stress of persecution became nominal Mohammedans and intermarried with the invaders. The

Kizilbash in the district near Malatia, unlike their brethren in Dersim, are peaceable, well-behaved agriculturalists, most of whom have entirely given up nomadic life. In general the Kizilbash are a frank, good-natured people, eager to be amused, very ready to ask and answer questions, hospitable, easy to deal with, industrious when work is necessary, and faithful when they have given their word, although very ready to rob and even to kill those to whom they are not under obligation. Morally they are superior to their neighbours. They deteriorate rapidly under new or adverse conditions, becoming more suspicious and treacherous. When among the Turks, they swear that they are good Sunni Mohammedans, although in reality their religion is a mixture of

IN THE CAÑON BELOW KEBAN MADEN.

Shiite Mohammedanism and Christianity, with perhaps a trace of primitive paganism. Accurate information is hard to obtain, because in talking with a Christian they try to make their religion appear like Christianity. For instance, a prominent agha, or village chief, said to me, "We have four great prophets, Adam, Moses, David, and Jesus, of whom Jesus is the greatest. We have four holy books, the Gospels. All religions are but different roads to the same end—one long, one short—one easy, one hard. You go yours, and we go ours." When I tried to talk about Mohammed, he avoided the subject as though it were unpleasant, so that I could learn nothing. The Kizilbash never pray in private, but only when led by one of their sehids, or religious chiefs,

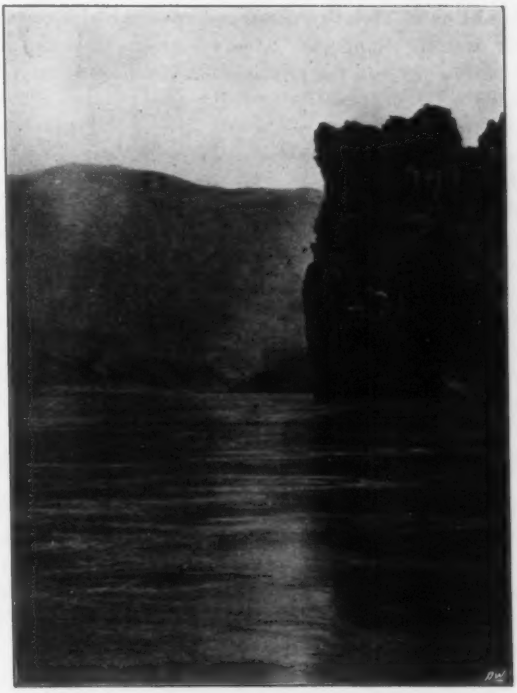
who have great influence among them, and who go freely and safely from tribe to tribe even during times of feud. So common are feuds, and so respected are the sehids, that the business of conducting travellers or of carrying freight is wholly in their hands. At certain times they observe a sort of sacrament, which closely resembles the Christian Communion Service. No competent observer seems to have witnessed this, and it is known only by report. The Kizilbash reverence all Christian sanctuaries and churches, and will even go into a church where service is being conducted, and take part, kneeling and bowing with the people. To be sure, they will do the same thing in a Sunni mosque, but in the latter case it is for fear of persecution, while in the former it is a matter of their own inclinations.

The Euphrates, as it winds through the Malatia plain, flows slowly and divides into a network of channels, enclosing islands of sand or gravel nearly level with the flood-plain. The latter, often half a mile wide, is bounded by bluffs from 30 to 50 feet high, cut in the alluvial deposit which forms the Malatia plain. Villages, especially on the left side, are numerous and prosperous, being usually beyond the flood-plain, although some lie at its edge.

At Kala, close to the most western point of the great bend, there is, on the left side of the river, a large rock, which the Haldis, or Naïri, long ago fashioned into a castle by excavating platforms and steps, and building walls. Behind the village, on the steep slope of Mushar mountain, are situated several famous holy places. The first, 400 feet above the river, is a raised platform of stone and mud, said to be the grave of an Armenian girl who cared for the great church on the top of the mountain. The Kizilbash aghas of the village are honoured by being buried here, although the common people must be content to lay their dead by the river. Five hundred and fifty feet higher is found a Turkish holy place, the grave of a man called Hassan, in a small cave, which has been walled in and furnished with many gaudy and some valuable offerings. Outside is a great square altar of rough stones, all covered with the gore of the scores of sheep and goats, which are brought as sacrifices by both Christians and Mohammedans, and which are cooked in huge copper caldrons hung from great beams. The horns of the offerings are piled on another altar, and the meat is often eaten in the holy place itself, the bones being thrown into a little cave back of the main cave. The shrine has no guardian, but it is regarded with such veneration by men of all religions that the most valuable of the offerings are perfectly safe from pilferers. The third, and least visited, holy place is an old well-built church with massive buttresses and arches, located on the bleak mountain-top 2400 feet above the river. A more unpromising or inaccessible site for a church can hardly be imagined. The view from Surp Aharon, as the Armenians call the church, or Mushar Kilise, as the Turks call it, is very extensive, including the

snow-capped Dersim and Anti-Taurus mountains on the north, the western extension of the Harput mountains on the east, the Taurus mountains on the south, and on the west the broad brown expanse of the Malatia plain, bounded on the east by the blue network of the Euphrates, and on the west by the range of Aghaja Dagh, cut by the V-shaped cleft of the Tokma gorge.

Returning to the river, the reedy, bushy islands, or the banks of shingle between the branches of the river, are the resort of all kinds



TRIPLE ROCK, IN THE GORGE AN HOUR BELOW KEBAN MADEN.

of water-birds—ibis, black divers, storks, bustards, herons, cranes, and many smaller birds. The current was slow and the voyage monotonous as we floated past the mouth of the Kuru Chai, whose valley the Malatia-Sivas road follows for two days' journey, and past the large Tokma Su from Gurun and Derende, until we reach Pirot, where the road crosses the Euphrates. Here the mountains again approach the river, leaving on either side a strip of smooth green fields dotted with trees and houses. Behind this on the right rises the first ridge of

the Taurus, from 4000 to 5000 feet above the river, and green clear to the snow-line, where verdant wheatfields lie close to snow-filled valleys from which shining little brooks tumble down the steep slope. Although the view is not wild or grand, it is most attractive, because of its quiet strength joined with real verdure—a rare element in the landscape of Eastern Turkey.

For 6 miles we skirted the base of the mountains, which, approaching gradually nearer the river, cause it to become more narrow and swift. Near Kemur Khan, on the left side, is a cuneiform inscription recounting an expedition of Tiglath Pileser, and speaking of a certain bridge, presumably over the Euphrates. Just up-stream from the inscription is a fairly narrow place in the river, with low cliffs on either side which might readily serve as piers of a bridge. As we passed this point, our kellekjis volunteered the information that they had heard from their fathers that in old times there was a bridge here, of which they—the fathers—had in their youth seen a few stones.

At Kemur Khan the river turns at right angles and goes south by east through a remarkably straight gorge 12 miles long and nearly 4000 feet deep. The scenery is even finer than in the preceding gorges. The dark, steep, gloomy walls of basalt and metamorphic shale are terraced at an elevation a few hundred feet above the river, and on each terrace or nestled in each tiny valley are one or two houses and a patch of bright green fields. In some cases the fields are on slopes so steep that it seems as though the sower could scarcely find a footing. Far above the fields white patches of snow contrast strongly, in spring at least, with the black and green walls of the cañon, and send little streams cascading down through rough gashes in the resistant rock, amidst a chaos of huge boulders and trees. In this gorge our real difficulties began. Our Armenian kellekjis, who knew the river thoroughly, as far as Kemur Khan, were now beyond their accustomed track and ready to be afraid of everything. The first rapid in the gorge looked to them so bad that we made a portage of between 2 and 3 miles around both that and the next rapid, climbing 1200 feet up the steep slope over the roughest kind of road. If the kellekjis had not been so timorous, the rapids might easily have been shot, and we should have been saved twenty hours.

As we were about to embark below the portage, after a night spent on the river-bank, a raft of logs passed us manned by two almost naked Kurds, with wooden tridents in their hands, and strings of gourds around their waists for life-preservers. They carry wood from Izoghlu through the Kemur Khan gorge to Kefferdis. We followed the men, and after a few minutes shot a fairly large rapid, at the bottom of which was a big whirlpool. Our men, with their spoon-shaped walnut paddles, were able to pull us out of it, but the Kurds could do nothing with their tridents, and were carried far up-stream. Finally

they had to land and haul their raft down to a point below the whirlpool.

Through the whole length of the gorge we went at an average rate of 5 miles an hour, between walls of solid rock which come down sheer to the narrow stream, and are broken only by precipitous gullies entering at grade and bounded by jagged cliffs with needle-like points. The mouths of these gullies are footed by fan deltas, which have been pushed out into the river, forming dams, over the outer ends of which

FAULT IN THE GORGE BELOW KEBAN MADEN.

the water pours in foaming rapids. We shot into these over smooth rounded waves, like the long swells of the ocean, but in a moment were among the breakers, which tossed the light raft up and down like a cork, and often came over us, breaking up-stream, as is usual in rapids. The kellekjis paddled with all their might. The raft spun round and round, so that we saw the wild mountains on every side without turning our heads.

Near the end of the gorge, where the mountains become lower, a

good-sized brook from Merjimud, coming in on the left through a fine cañon, has built a large fan. The size of the rapid thus formed frightened our kellekjis so much that we could not persuade them to shoot it, and were obliged to spend two hours in letting the kellek down past it by ropes. While we were doing this, the Kurds on the wood-raft overtook us. Lying flat on the logs, they shot through, not over the rapid, going into wave after wave with 4 or 5 feet of water over them, and coming out at the bottom with a triumphant yell.

At the mouth of Mamash Chai we left the transverse cañon, and turned at right angles to the east by north into the broad longitudinal valley in line with Lake Gyuljuk. On looking into the valley from any of the surrounding mountains, it appears so broad and well matured that one feels certain at first that the Euphrates must come down its whole length from the west-south-west, the actual cañon of the river seeming to be merely the bed of a short tributary. The part of the main stream in the open longitudinal valley and the tributary, Mamash Chai, lying directly in line with one another and at right angles to the transverse cañon, have incised in the valley-floor a steep-sided trench from 150 to 250 feet deep, and wholly filled at the bottom by the streams, which flow between rock walls without a flood-plain. Most of the valleys in this immediate region show the same feature of a flat-bottomed old valley with a small trench-like new valley, without a flood-plain, incised in the floor. Thirty miles north in the Harput mountains such newly incised valleys are not found. They occur on a small scale 30 miles north-west, in the western extension of the Harput mountains, around which flows the Euphrates river, and again 20 miles further east, in the valley of the Tigris river. Probably this conformation is due to an uplift of the region at a comparatively recent date, affecting most strongly the Taurus mountains where they are traversed by the Euphrates river. The minimum elevation seems to have been at least 500 feet. The immediate vicinity of Harput may have been unaffected, or, as is equally probable, the cutting down of the bed of the Euphrates has not yet proceeded far enough up-stream to affect these mountains, although they may have been uplifted. In the Tigris basin the very small dimensions of the newly incised valleys may be due to slight uplift or to the comparative slowness with which the small stream of the upper Tigris scours out its bed. The 8 miles of the course of the Euphrates, along the open longitudinal valley in line with Lake Gyuljuk, are over numerous rapids, caused not by fans but by inequalities in the bed-rock, and thus indicating that the revival of the river by uplift of the surrounding country is very recent.

Near Aivose, just below the ferry where the road from Harput to Shiro crosses the river at the head of a dangerous rapid, which, unlike those just above it, is caused by a detrital fan, thirty or forty of the villagers tried to prevent us by force from going further, but were soon

persuaded to take up our craft and carry it a quarter of a mile around the rapid. They could not understand why any one should make such a dangerous journey, and especially why any one should take notes all the time, and so, with oriental logic, they concluded that we had some secret purpose which must be opposed to their interests. Our own servants were equally unable to understand our purpose, although I tried to explain. Often I heard them answering the questions of inquisitive villagers, "What are these men doing?" "We don't know. Perhaps they are going to make a bridge, or a wagon-road, or a railroad. More likely they have a secret commission from the king. They say they are not paid for making this journey, but we know better; they are not such fools as all that. They know everything: they see a stone or a plant, a brook or a mountain, and they know it. They even know what is in a place before they have visited it. They write everything. If you want to know any more, ask them. What do we know?"

KUZZLEBASH KURD CROSSING THE EUPHRATES ON INFLATED SHEEPSKIN.

The villagers at Aivose feared not only that we should harm them, but also that we should be drowned, in which case the Government might hold them responsible for the foreigners, the "men with hats." The people here, as well as many others with whom we talked, both above and below this point, asserted that no one ever had navigated or could navigate the river from Aivose to Chunkush. Von Moltke's journey seems to have been forgotten.

Leaving the villagers, who had become quite friendly as they carried our goods around the rapid, we boarded the kellek once more, and in less than ten minutes were at the angle where the river, turning once more to the south from the longitudinal valley, enters an immense crooked transverse cañon, the last and longest of the great gorges, 30 miles long and 5000 feet deep. Before we knew it we were at the head of a rapid worse than any that we had yet shot, or around which we had made portages. It seems to be due partly to the structure of the bed-rock and partly to the fan of the Uslu brook, which flows into the river just in the middle of the rapid over a series of small cascades, which, as seen from the river, appear to be caused by the brook's own fan. The kellekjis wanted to make another portage, but we insisted on shooting the rapid. Although we made the passage safely, the men's nerves were so completely unstrung that when we landed soon after at

the head of another large bed-rock rapid, they absolutely refused to go on. One was sent to find a village and get men and animals to help in making a portage. He found a village after a hard climb of an hour or more, but instead of going to it he hid till after dark, and then returned to us, because, as he said, if the Kurds knew that we were encamped beside the river, they would come and rob or even kill us during the night. The other Armenian, when told to take some baggage off the safely moored kellek, said, "If I ever set foot on that kellek again I know that I shall die. Then who will take care of my wife and children? You haven't any hearts. The mountains are savage, the river is savage, the people are savage, but you don't fear them. Don't you even fear God?"

He was full of superstition and was in terror, partly because he had dreamed the night before that some of his friends were dying. This night he dreamed that we Americans were shooting pistols, which, curiously enough, seemed to encourage him greatly.

In the morning we made our portage, a long hard one involving a climb of 900 feet up out of the steepest parts of the cañon, and at twenty minutes past five in the afternoon were ready to embark, 2 miles from our camp of the previous night. Floating very rapidly for nearly an hour, we passed the sulphurous hot springs of Tilek, which rise on both sides of the river below high-water mark. They contain chiefly hydrogen sulphide and calcite. In July, 1900, I visited them and found the temperature to be 114° Fahr., while that of the surrounding air was 103° Fahr. at 4.30 p.m. On account of the inaccessibility of the springs, they are but little visited, although reputed very beneficial for skin and rheumatic diseases. The favourite method of treatment is to bathe the patient half an hour, and then bury him up to the neck in the hot river sand for two hours, repeating this process four or five times in a day.

Near Tilek the river turns more directly south and passes through magnificent scenery. At the bottom, schist, formed by the metamorphism of shale, forms almost perpendicular walls, which we estimated as nearly 400 feet high. Above is a terrace, from which green wooded upper walls rise less steeply to the mountain-tops a mile above our heads. The larger tributaries cut through the apparently perpendicular lower wall in steep-sided narrow cañons, entering the main stream at grade, while several small streams have not yet cut down to grade, and cascade over the cliffs in a series of white falls.

These hanging valleys and many other characteristic features of the Euphrates cañon correspond closely to what is described in the Grand cañon of the Colorado river, showing that the two rivers are of nearly the same age. The Colorado cañon is much longer than that of the Euphrates, and is cut through a plateau of nearly horizontal strata instead of through a range of mountains formed of much distorted

strata; but in both cases the depth of the cañon and the inclination of the walls, very steep at the bottom and more gentle above, are approximately the same. Both rivers are so young that they have not yet established thoroughly graded channels, but no waterfalls are found such as we should expect in extremely young streams.* There are, however, the two kinds of rapids which I have already mentioned, viz. those due to outcrops of hard rock which have been worn back so far as to present a regular but nevertheless very rapid descent, and those due to the damming of the stream by fans of detritus brought in by tributaries. It was by these that the famous journey of Powell down

ENTRANCE TO THE GREAT CAÑON AT KEMUR KHAN, LOOKING SOUTH.

the Colorado was made so dangerous.† We found that as a rule the bed-rock rapids are longer, but the fan rapids are more steep and dangerous. They indicate that the rivers are approaching, but have not yet reached, the stage of maturity, when the whole channel assumes a graded character.

The junction of the side streams with the main river is another interesting indication of youth. The majority, as has been said, enter

* See Gilbert, G. K., Engineer Dept. U.S. Army, 'Report upon Geog. and Geol. Expl. West of 100th Meridian,' vol. iii. (Washington, 1875) part i. pp. 70–75.

† See Powell, J. W., 'Exploration of the Colorado River of the West and its Tributaries.' Washington: 1875.

at grade through narrow steep-sided cañons, but some of the smaller tributaries and a number of wet-weather torrents have not been able to carve valleys as rapidly as the main stream has incised its cañon, and so have been left hanging at various levels on the cañon wall. They are in marked contrast to the hanging valleys described in glaciated countries such as Switzerland and Norway. The latter enter main valleys far broader than the streams that occupy them—so broad, indeed, that the main rivers have room to wander over wide flood-plains, bordered often by narrow strips of plain which graduate into the steep valley wall without any sudden angle. The others, on the contrary, send their streams cascading over the precipice directly into the Euphrates river, whose valley is so narrow that not only is there no flood-plain, but the water washes the rocky base of the almost perpendicular cliffs. The Colorado river, it will be remembered, has just such hanging valleys where it passes through the harder crystalline rocks. These two cases, where the discordance of side valleys seems to be incontestably due wholly to river-erosion, are in such marked contrast to the discordance of valleys of glaciated countries, that it is very hard to believe that the latter could have been due to river-erosion. If we regard them as the product of glacial erosion, we have what seems to be an adequate explanation of their difference from those that are certainly of river origin.*

In the middle of the fan delta of Halogé Chai, a small tributary of the Euphrates which enters the main stream at grade, lies an immense white boulder, 30 feet in diameter, on the top of which are perched a number of boulders of other kinds, small only in comparison with the monster on which they rest. Probably the surface of the delta was formerly high enough to cover completely the large boulder above which the others were laid down. As the delta was worn away, the latter were left resting on the former. That water could transport and smooth a boulder of such enormous size seems incredible, but the stone is there at a considerable distance from its point of origin, and must have been carried down the slope to its present position by floods.†

A mile below this we stopped at the head of the biggest rapid yet seen, and of course the men wanted to make a portage. As our time was growing short, and a portage would take nearly a day, we decided to leave the light baggage for the men to carry over the quarter-mile chord of the great boulder-strewn fan which caused the rapid, and ourselves take the raft down. They expected that we should be drowned, and they would be left alone without a kellek in the bottom of that almost inaccessible gorge; but in spite of their entreaties we pushed off, and

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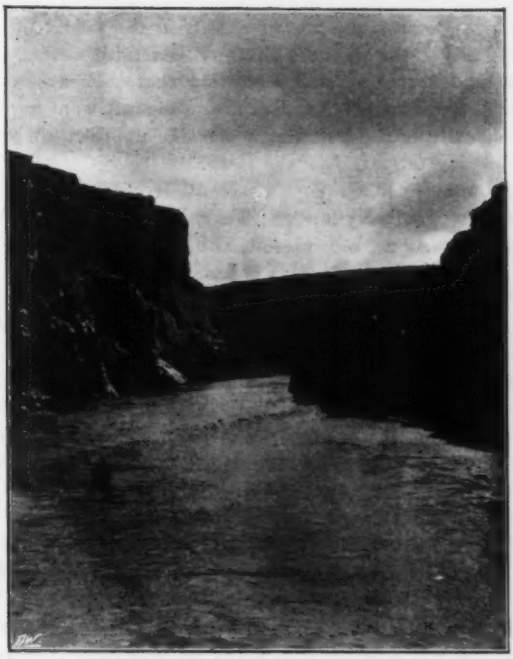
* See Davis, W. M., "An Excursion to the Grand Cañon of the Colorado," *Bulletin* of the Museum of Comp. Zoology at Harvard College, vol. xxxviii. (Cambridge, 1901) p. 169.

† See Gilbert, G. K., *op. cit.*, p. 71.

although we paddled hard were in the rapid before we had reached mid-stream. There was a long swift exhilarating shoot over a tilting stretch of water, and we were among dashing waves which seemed to be 10 feet high. As the kellek rose on the first one, we stopped paddling and seized the ropes. We whirled round and round more swiftly than ever before, this time not looking at the grandeur of the mountains, but only at the waves, which broke over us again and again, wetting us to the skin. The kellek stood the passage perfectly, and below the rapids



LOOKING UP-STREAM IN THE CAÑON OF THE EUPHRATES AT MORFA, JUST SOUTH OF THE GERGER RIDGE.

we brought it safely ashore. When at last the men overtook us, they seemed to feel that our preservation was miraculous.

"You're not men; you're jinner (spirits)!" one of them exclaimed.

From here to Chunkush the gorge is cut almost entirely through limestone. Travelling at the rate of 8 miles an hour, we passed for 18 miles through a continuous succession of bed-rock rapids, many of them larger than those around which we had made portages. We spent the night on a tiny ledge, where the precipice overhung us and partly

protected us from the light rain that fell toward morning. Although neither the river, the mountains, nor the Kurds had harmed us, the men seemed determined to find something of which to be afraid.

"If we sleep here, the bears will come to the top of the precipice and throw stones on us," they said, when we proposed to land on the narrow ledge.

The next to the worst rapid is 2 miles above Chunkush, where the one of our kellekjis whose sleep had been disturbed by dreams was washed overboard by the waves. Most fortunately his companion seized his arm, and we all pulled him on to the raft at the imminent risk of upsetting it. A few minutes later, while we were still in the same long rapid, we encountered one of the dangers that we had most feared. The raft stuck on a hidden rock in such a position that the waves would soon have battered the skins till they leaked and the raft went to pieces; but we got off by shifting the load first to one side and then the other, thus, as it were, prying the raft over the stone.

From Chunkush to Gerger, where our river journey ended, the mountains grew gradually lower. The river presents no special obstacles and no points of marked interest, although the scenery is still fine. The large Chermug Chai, a brook which enters on the left, has two main branches: one, the Kizilchabuk, is a wet-weather stream from the south-east, where it drains part of the plain north-west of Diarbekir; the other has always a large stream. Its main source is halfway between Chunkush and Chermug, where there is in the limestone a great sink-hole over 400 feet deep, with an aperture scarcely 50 feet by 20. The water from this reaches the surface 2½ miles farther east, near the village of Sinek, from which the stream takes its name. A smaller branch comes from the locally famous sulphur hot springs of Chermug.

At Gerger, where the Euphrates passes through the last outlying ridge of the Taurus mountains, we find one of the narrowest gorges. The hard limestone mountains rise over 2000 feet above the river, the north side of the ridge being bounded by a long line of cliffs 400 or 500 feet high, from the base of which there is a much more gentle slope to Petterge Chai. The south side slopes off gradually in well-rounded gentle hills which can be traversed with great difficulty because of the rough pits and sharp edges into which the limestone weathers, and which have been denuded of soil because of the deforesting which has taken place. As one stands on the top of the ridge, a long broad depression is here visible—the old valley of the Euphrates stretching to the south-west nearly parallel to the mountains—but there is no sign of the river, whose present course is marked only by a slight line of cliffs. An observer who did not know that the river intervened would think that he could easily walk to the hills on the opposite side. The river now flows in a narrow cañon with perpendicular walls 450 feet high.

This journey of 190 miles by water from Akhor to Gerger occupied

seven days, including the unnecessary portages, although the time actually required for floating down the river was only thirty-seven hours. The 50 miles from Akhor to the Kara Su occupied ten hours, the 35 miles to the beginning of the Malatia Plain six hours, the 45 miles to Kemur Khan ten and a half hours, and the remaining 60 miles to Gerger ten and a half hours. The total descent as measured by aneroid is 1250 feet, the steepest part being near the big rapid just below Tilek, 100 feet in 6 miles, and the gentlest descent being in the Malatia plain, 100 feet in 55 miles. We found that the map as given by Von Moltke needs considerable correction.

At present the roads avoid the gorges of the river and climb over the high mountains. As soon as railroads are introduced, there can be no doubt but that, as usual, one of the main lines will follow the easy grade of the river.

Although the utilization of the Euphrates river for industrial purposes may be far in the future, it is, nevertheless, a problem which will some day be of great importance. The most valuable part of the river's basin is Mesopotamia, which begins south of our journey's limit, and of which I cannot speak from personal knowledge. A comparison of the accounts of ancient and modern travellers shows, however, that its present poverty is almost as remarkable as was its ancient fertility and wealth. That region is described as being so rapidly and completely ruined by the invasion of the sand of the desert on the south-west side, and by the constant shifting of the channel of the Euphrates river in the centre, that the future will be even more desolate than the present unless measures are taken to resist these encroachments. Against both the river and the desert the means of protection lies in controlling the river itself. In ancient times the control of the water was effected by a great system of canals, embankments, and reservoirs in Lower Mesopotamia. These were in constant need of expensive repairs, and their breaking was the cause of frequent disaster. England has found that the only way to control the Nile is to control its sources, and, having finished the work of cutting the sudd, she is now making the huge dam at Assuan, and considering the far greater task of regulating the outflow of the great African lakes. It is a work of great magnitude, involving an immense outlay of capital, but there is no doubt that it will prove permanently successful. The problem presented by the Nile is similar to that presented by the Euphrates, and the two must be similarly dealt with, although there is one important difference. In the former case, the chief problem is to conduct the water to the sea by the right channels, in the right quantities, and at the right time. In the Euphrates river, the problem is to use the water before it reaches the sea.

When the Euphrates river is properly controlled, it will serve two great uses: it will be a great producer of power, and it will accomplish the vastly more important work of irrigating Mesopotamia. More than

three-fourths of the rainfall of the upper Euphrates basin falls in the seven months from October to April. If the precipitation of this period could be retained among the mountains, and allowed to escape during the late spring and summer, it would not only save Mesopotamia from the annual floods which carry away great sections of land along the banks and convert other large areas into disease-germinating swamps, but would also accomplish the far more important result of enabling vast tracts of the best kind of land to be irrigated and reclaimed from the desert. The extent of the entire region that can be reclaimed by means of the river seems to be as great as that of England. Although Mesopotamia can produce two crops a year, its population is scarcely a million; yet it might support ten times as many people, and still export in great quantities all sorts of food-stuffs. It is destined to be one of the richest parts of the world if its development is unhindered. The great need, so far as merely physical matters are concerned, is the controlling of the Euphrates river.

The best means of accomplishing this seems to be by building reservoirs in the great depression of the upper Euphrates valley between the Taurus and anti-Taurus ranges. This contains a series of small parallel mountain ridges enclosing many plains, generally, although on slight ground, called lake-basins. In the middle of each is a stream, which passes out at the lower end through a steep narrow valley. The plains can easily be converted into reservoirs by the construction of simple dams. The expense, which would not be excessive, would certainly be met, in part at least, by the water-power thus rendered available, while the storing of the surplus water of the winter would be of incalculable value in irrigating Mesopotamia. Of course, the value of the land covered by the reservoirs must be considered. Fortunately it is slight, for although the larger plains are very valuable, the smaller ones are often so cut up by small watercourses that they have little value for agriculture, and might readily be converted into lakes. It is the work of the engineer to determine the best sites for dams, but the possibility of building them seems patent to any one who has seen the plains and gorges. The progress of civilization will necessitate the building of such reservoirs, and the only place where they can be profitably built is north of the Taurus mountains.

What has been said of the Euphrates river is, with certain modifications, true of the Tigris also. Reservoirs can probably be built east of or among the Zagros mountains, just as they certainly can be built north of the Taurus mountains. From the earliest times until now the history of the Mesopotamian plain has been sharply separated from that of the mountains to the north and north-east. In the future the history of the two regions must be one, because the development of Mesopotamia depends absolutely on the great rivers which flow from the mountains, and must there be controlled.

REPORT ON THE IDENTIFICATION OF THE BAY OF SAN FELIPE AND SANTIAGO VISITED BY QUIROS IN 1606.*

THE material for the voyage of Quiros and Torres from Lima across the Pacific in 1606 is enumerated in an appendix, with a table of the different islands discovered, and the latitudes recorded.

The hypothesis that the bay of San Felipe and Santiago of Quiros can be identified with Port Curtis, or any other bay on the Australian coast, is entirely incompatible with the accounts of the voyage. Putting on one side for the moment the disagreement of the descriptions given both of the land and natives, it would be necessary to assume, not only that the latitude of Espiritu Santo was falsified, but that every latitude, every course steered, and every detail given of the whole voyage was also falsified. This would not only be an astounding assumption, as the various accounts agree very nearly with one another in all important details, with just as much difference as affords evidence of independence and truth, but would make it hopeless to attempt to identify anything; whereas, by following the descriptions given by the two sailors, leaders of the expedition, every island seen or visited can be perfectly and satisfactorily determined.

Making the usual allowance for exaggerated description and imperfect examination by explorers who naturally wished to make the most of their discoveries, nearly every detail fits in; and probably no identification of an early voyage is more complete than that of the bay of San Felipe and Santiago with the bay now so named in the island of Espiritu Santo in the New Hebrides.

The general facts as to the courses steered and distances supposed to be run are given in the appendix, but it is the latter part of the voyage that it is desirable to deal with in detail, to show what the evidence is for the received view of the position of Espiritu Santo.

On February 21, 1606, sixty-two days after leaving Lima, the ships were in or about the parallel 10° 30′ S. lat., which they were running along as nearly as possible with the avowed intention of making the Island of Santa Cruz, visited by Quiros with Mendaña in 1595, and ascertained to be in that latitude. On March 2 they touched at a low inhabited island which they called Gente Hermosa. This is probably the island so called on the charts, in 11° S. and 171° 3′ W.

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* This is the report of a special committee appointed by the Council of the Royal Geographical Society, at the request of the Melbourne branch of the Royal Australasian Geographical Society, to consider a proposition recently advanced that the bay of S. Felipé and Santiago, visited and so named by Quiros, was the bay of Port Curtis in Queensland: the committee consisted of Sir Clements R. Markham, K.C.B., President R.G.S.; Admiral Sir W. J. L. Wharton, K.C.B., Hydrographer to the Admiralty; Admiral Sir Richard E. Tracey, K.C.B.; and William Foster, Esq., late Secretary to the Hakluyt Society.

On April 7 they sighted a high black island, one of a group, in about 10° S., being then by their reckoning 1940 leagues from Lima. They give its name as Taumaco, and it is no doubt the highest of the Duff islands, which lie in this latitude (see beyond). Here they remained for twelve days, and obtained from the natives information of many large islands to the south. One of these was called Manicolo.

Now Mallicolo is one of the larger of the New Hebrides, and lies 360 miles south of Duff islands. Captain Cook gives Manicolo as one form of the name. But it is also possible that Vanikoro, which is a large island compared to the Duff islands, and is only 80 miles distant, may be the Manicolo of the Taumaco islanders, because the French explorer, D'Urville, in 1828, understood Manicolo to be the form of the name given to him at Tucopia as that of the island on which the ships of La Perouse had been lost.

Torquemada describes at Taumaco what he calls a fort, and says it is a small island situated inside the reefs, made by hand of live rocks, on which were about sixty houses. Such an island, with a coral-rock wall round it, with houses and coconuts, exists to this day at the largest of the Duff islands, and forms a very remarkable item of identification.

Sailing from Taumaco on April 16 or 19, and steering S.S.E. in search of the large islands described to them, the expedition sighted on the 21st a small island called Tucopia, in 12° or 12° 30′ S. This was high and inhabited, and can be absolutely identified with the island named Tucopia at present, which lies 150 miles S.E. by S. from the Duff islands, is about 1300 feet high, and is in 12° 15′ S. This island was known on the charts for some years as Barwell island, the ship *Barwell* having sighted and reported it in 1798. But in 1813 a German named Martin Bushart was left on it by the *Hunter*, and lived there until 1826, when Captain Dillon, who had been in the *Hunter*, called again at the island, and found him there still. Dillon learnt from him that the natives called the island Tucopia. Bushart had seen articles of European make, which gave Dillon the first clue to the fate of La Perouse.

In 1828 Captain Dumont D'Urville visited this island for news of La Perouse, and calls it Tikopia, which was his idea of the native pronunciation. Captain D'Urville relates that he obtained from the natives through the interpretation of Bushart, who spoke their language perfectly, the names of islands around, and that one of them was called Taumako, and lay to the north-west. These two islands may thus be considered as absolutely identified, though the name Taumaco does not yet appear on the charts, because the Duff islands have never yet been properly examined, and it is not known to which of them the name applies.

From Tucopia Quiros sailed south to lat. 14° S. and then west, and a day or two later, on April 25, discovered a high island with a volcano, about 3 miles in diameter, in 14° 30′ S. They called it Nuestra Señora

de la Luz, and found it to be inhabited. This is certainly Merelav of the Banks group, which lies in 14° 25′ S. and answers the description, for though not now in activity there is a crater on the summit.

When off this volcano they saw other high islands, west, south-west, and south-east. This answers to the locality. Gaua of the Banks group was to the west, Santo and Aurora of the New Hebrides group to the south-west and south-east respectively, all mountainous and in sight.

After visiting Gaua, which they called Santa Maria, they steered for the large land to the south, and arrived on May 1 at a bay in it, to which they gave the name of S. Felipe and Santiago. The latitude of its head is given by Quiros as 15° 20′ S., and by Torres as 15° 40′ S.

The large bay at the north end of Santo has only been imperfectly explored, but sufficient is known of it to make certain that it was the bay visited by Quiros. The most salient features are its size (10 miles wide, 15 the length of one side, and 30 of the other) and great depth, and the freedom from rocks, shoals, or other impediments to navigation. When the two ships left it, it is related that, finding the wind strong, they endeavoured to return to the port of Vera Cruz at its head, and that for three days they worked to windward with this intention. It is especially mentioned that they could find no anchorage elsewhere, and, finally, Quiros was blown out of the bay and the ships parted, for Torres had reached the head of the bay again.

Captain Cook, in 1774, vainly tried to find anchorage when drifting in the bay and in danger of being set on shore, and found the water very deep right up to the steep shore. The prevailing direction of the wind in June, when Quiros was there, is strong from the south-east or out of this bay, and it can be safely stated that there is no other bay in this part of the Pacific, including the whole eastern coast of Australia, in which these circumstances could have occurred. The axis of the bay is stated to be north and south.

The bay of Port Curtis is not only so narrow that no ships could have acted in this manner, but it is everywhere of moderate depth, is much encumbered with rocks and shoals, and the sea outside is for miles of such small depth that a ship can anchor anywhere. Moreover, the trade wind which prevails in June blows right up Port Curtis, which lies W.N.W. and E.S.E., and the difficulty is not to get into it, but to get out. Of all sheets of water on the Pacific shores it answers least to the description of the bay of S. Felipe and Santiago.

More than this, most important direct evidence, in favour of the bay in Santo, exists in the map of it, drawn by Don Diego de Prado y Tovar, —who was chief pilot or captain with Quiros, but left his ship for that of Torres at Taumaco—and which is still in the archives at Simancas, where it was unearthed in 1876. It was published in facsimile in the *Boletin* of the Geographical Society of Madrid in 1878 (vol. iv. p. 92), and is also reproduced in Mr. Collingridge's 'Discovery of Australia.' The

shape of the bay is precisely that of the bay at the north end of Santo, and the latitude of its head is given as 15° 20′. Captain Cook determined it as 15° 15′. No one who looks at this chart could for a moment imagine that it could be Port Curtis.

It is scarcely necessary to refer to the description of natives, weapons, dwellings, produce, vegetation, none of which can refer to the Australian coast, while they all agree with what is known of the New Hebrides. The marble spoken of is easily accounted for by the cliffs of upraised white coral which are a common feature in all the New Hebrides, and which an ardent imagination might easily mistake for marble.

Torres, when he left the bay of San Felipe, did so with the intention of sailing round the island, as he calls it, and actually did sail down the west side, being continually forced by the trade winds away from it, and so down an open sea to 21° S. As Port Curtis is on the eastern coast of Australia, this would be impossible. Moreover, when he turned north he could not have made the east point of New Guinea as he describes, and which he tried to pass to the eastward, had he sailed south from Port Curtis; nor could Quiros have made his clear course to the northward on his way back to America had he started from Port Curtis.

It may, perhaps, be added that off the coast of Australia there are no such islands as those described as Taumaco, Tucopia, Nuestra Señora de la Luz, Santa Maria, and the other islands seen southward from Nuestra Señora de la Luz. All the islands north and east of Port Curtis for many miles are small, low sandy islands, with no inhabitants; neither is there any volcano nearer to Port Curtis than those in the New Hebrides and Banks groups.

APPENDIX.

Note on the Authorities for the Voyage of Quiros.

1. The fullest narrative of the voyage of Quiros is in a work called the 'Monarquia Indiana,' by Fray Juan de Torquemada (lib. v., caps. 64 to 69, pages 738 to 756 of vol. i.). This work was published at Seville, 1615, the licences and approbations being dated 1612 and 1613. The first edition is very scarce. The second edition, in 3 vols., was published at Madrid in 1723. Torquemada was a Franciscan Friar living at Mexico when Quiros and his crew arrived after the voyage. In one of his 'Memorials' Quiros says that he left an information of his discoveries witnessed by ten of his crew (see Dalrymple, i. p. 145). Burney, therefore, looks upon the account in the 'Monarquia Indiana' as given on the authority of Quiros. Dalrymple and Burney use it largely, but it has never before been translated.

2. Quiros, on his return to Spain, presented eight 'Memorials' to Philip III. relative to his being employed again to settle his so-called "Australia." They consist mainly of exaggerated accounts of his discovery. The first 'Memorial' was published at Seville, and is given by Purchas (iv. p. 1427). The eighth is also given by Purchas in translation. Dalrymple gives them both in English (i. p. 145 and 162). The first gives a list of the names of islands discovered, but very little else that is not in Torquemada.

3. Quiros wrote an account of his life, including his voyage with Mendaña to the Marquesas and Santa Cruz, and his own voyage, with several royal decrees, memorials, and other documents. It has been published in vol. v. of the 'Coleccion de Documentos Ineditos' (Madrid).

4. Friar Diego de Cordova y Salinas, a Franciscan, wrote 'Historia de la Religion Seraphica,' which was printed at Lima in 1630; second edition, Madrid, 1643. Both editions are excessively scarce. In this work there is a brief account of the voyage of Quiros, copied from Torquemada.

5. Fray Antonio Daza wrote a 'Cronica General de la orden da San Francisco,' and in his fourth part he gives the text of the 'Auto de Posesion,' drawn up by Quiros when he took possession of his island "Australia del Espiritu Santo." It gives the latitude.

6. Dr. Juan Luis Arias addressed a 'Memorial' to King Philip III. on the extension of the Church by the conversion of the infidels reported by Quiros. He was not in the expedition, but he had access to original documents, for he gives three important latitudes—of Taumaco, of Espiritu Santo, and of the furthest south of Torres. The 'Memorial' of Arias is given by Major in his 'Early Voyages to Terra Australis.'

7. Luis Vaez de Torres was the second in command under Quiros. He wrote a brief but very important 'Report' on the voyage, to Philip III., from Manilla, dated July 12, 1607. The original is mentioned by Navarrete as being at Simancas. There is a manuscript copy in the Biblioteca Nacional de Madrid (j. 2). Dalrymple obtained a copy, and made a translation, which he allowed Burney to publish in the appendix to his second volume. Major reprinted it in his 'Early Voyages to Australia' (Hakluyt Society, 1859). Lord Stanley of Alderley translated the manuscript copy at Madrid, and gave it as appendix vi. in his 'Philippine Islands' (Hakluyt Society, 1868). The letter is also reprinted in Collingridge's 'Discovery of Australia' (Sydney, 1895), p. 229. Torres gives twelve latitudes, but he is bad as regards dates, being supplemented in that respect by Torquemada.

8. Gaspar Gonzales de Leza, pilot in the ship of Quiros, wrote a narrative of great importance, which is in manuscript at the Madrid Library (j. 2). Lord Stanley gives several translated extracts from it, as explanatory notes to the 'Report' of Torres.

9. Diego de Prado y Tovar called himself captain of the *Capitana*, but he left Quiros to join Torres at Taumaco. Copies of two of his letters are in the Madrid Library (j. 2). A translation of one is given by Lord Stanley (p. 142 n.). The originals are at Simancas, and are printed in the 'Coleccion de Documentos Ineditos' (t. v.). They are reprinted by Collingridge (p. 246). Prado also drew four coloured maps, one of the bay of San Felipe y Santiago, and three of bays in New Guinea. On the first map he gives the latitude of the bay of San Felipe and Santiago. The originals are at Simancas, but they were reproduced in the *Boletin de la Sociedad Geografica de Madrid* (January, 1878), iv.: also reproduced by Collingridge without colour. Prado speaks of Quiros with contumely, calling him a liar and a madman. "A low and lying man who yesterday was a clerk in a merchant ship, and a Portuguese." Antonio, the bibliographer, also called him a Portuguese, said to be a native of Evora. It is a Spanish name.

10. Juan de Iturbe, the accountant on board the ship of Quiros, wrote a report of the voyage, dated at Mexico, March 25, 1607. It is in the Madrid Library (j. 2). Lord Stanley gives extracts from Iturbe as notes to the 'Report' of Torres.

Dalrymple, in his 'Historical Collection of Voyages in the Pacific' (1770, vol. i.), gives an account of the voyage of Quiros, chiefly from Torquemada (pp. 95–144), and he also printed the two 'Memorials' of Quiros.

Dates given by Quiros.	Courses.			Latitudes.				Longitudes.	Burney's deductions.	Islands.	Names.		Variation.
	Leza.	Quiros.	Torres.	Torres.	Quiros.	Leza.	Arias.				Quiros.	Torres.	
1605.													
Dec. 21 ...	—	W.S.W.	800 leagues W.S.W.	—	—	—	—	—	—	—	—	—	—
,, 25 ...	—	—	,,	26° S.	—	—	26° S.	—	—	—	—	—	—
1606.													
Jan. 26 ...	—	—	W.N.W.	24° 30′ S.	25° S.	24° 45′ S.	—	1000 leagues from Lima	58° 13′ W.	Island 4 leagues round	Encarnacion	Anegada (Leza)	—
,, ...	—	—	W. b. N.	24°	—	—	—	1075 leagues from Lima	—	Island 12 leagues round	San Juan Bautista	San Valerio	—
Feb. 2 ...	—	—	W.N.W.	21° 20′ S.	—	—	—	—	—	Large island, lag on in centre	Santelmo	"Isleta rasa"	—
,, 4 ...	—	—	N.W.	19°	—	20° S.	—	—	—	Four coral isles	Los 4 Coronados	Las Virgenes	North-easterly
,, 5 ...	—	—	—	—	18° 40′ S.	—	—	—	—	—	San Miguel Arcangel, Conversion de S. Pablo	—	—
,, 9 ...	—	—	W.N.W.	—	—	19° S.	—	—	—	Island to N.E.	La Dezena	Santa Polonia	—
,, 10 ...	—	—	—	18° 30′ S. S.E. point	—	1°	—	—	—	Inhabited island	Sagittaria (Ansa)	—	—
,, 11 ...	—	—	—	—	17° 40′ S., N.W. pt.	—	—	—	147° 2′ W.	—	—	—	—
,, 12 ...	—	—	—	—	—	16° 15′ S.	—	—	—	—	—	—	—
,, 13 ...	—	—	—	—	—	—	—	—	—	Low island	La Fugitiva (Makatea)	—	—
,, 14 ...	—	—	N.W. b. N.	16° 30′	—	15° S.	—	1398 leagues from Lima (L)	—	do.	—	—	1 point easterly
,, 15 ...	—	—	W. b. N.	10° 45′	16° 30′ S.	—	—	—	—	Low islands	Del Peregrino (Matakiva)	—	—
,, 21 ...	—	—	—	—	—	16° 15′ S.	—	—	—	—	—	—	—
,, 22 ...	—	—	—	10° S.	16° 34′ S.	16° 30′ S.	—	—	—	Low inhabited island	Gente Hermosa	Matanza	—
March 2 ...	Mar. 5 to Apr. 9, W. in 10th parallel	—	W.	32 days W., in 10th parallel	—	16° to 16° 30′	—	—	—	—	—	—	—
,, 3 ...													
,, 5 ...													
,, 22 ...													
April 7 ...	—	—	—	—	—	16° 10′ S.	16° S.	1940 leagues from Lima, 60 from Sta. Cruz	169° 45′ E.	High island	Monterey or Toumaco	Taumaco	—
,, 9 ...	—	—	—	—	—	—	—	—	—	—	—	—	—
Left Taumaco { 16* or 19† }	—	—	S.S.E.	12° 30′ S.	full 12°	—	—	—	—	—	Tucopia	N. S. de Loreto (L) Chucupia	—
April 21 ...	—	—	—	—	—	—	—	—	—	—	—	—	—
,, 22 ...	—	—	S.	—	—	—	—	—	—	—	N.S. de la Luz	Volcano island	—
,, 25 ...	—	—	—	14° 30 S.	14° 30′ S.	—	—	—	—	—	—	—	—
,, 27 ...	—	—	—	—	—	—	—	—	—	—	—	Sta Maria	—
,, 30 ...	—	S.W.	S.W.	—	—	—	—	—	—	In sight of La Cruz	—	—	—
May 1 ...	—	—	—	—	—	—	—	—	—	—	—	—	—
,, 2 ...	—	—	—	15° 40′ S.	15° 20′ S.	—	15° 20′ S.	—	—	—	Baia de San Felipe y Santiago, May 1 (L & I)	—	—
,, 3 ...	—	—	—	—	—	—	—	—	—	—	—	—	—
,, 8	—	—	—	—	—	—	—	—	—	—	—	—	—
June 11... ...	—	—	—	—	—	—	—	—	—	—	Vera Cruz, May 3 (L & I)	—	—
Quiros separated from Torres.	—	—	—	—	—	—	—	—	—	—	—	—	—
June 28 Torres sailed	—	—	S.W., N.W., and N.N.W.		—	—	to 21° S.	—	—	—	—	—	—

* Torquemada. † Mar. of Quiros.

Burney, in his 'History of Voyages in the South Sea' (vol. ii.), gives a more complete account of the voyage of Quiros based on Torquemada and the 'Report' of Torres. He traces the route with great care, and with the skilled hand of an expert (pp. 268–327). He also gives a map with the route.

Remarks on the Reliability of the Positions given in the Various Accounts of the Voyage of Quiros.

It has been suggested that the latitudes given for the voyage of Quiros were falsified to deceive the English, as was the custom with Spaniards. It was not the custom in books published by authority, and all books were so published. The latitudes given in narratives of Spanish voyages are, as a rule, more accurate than those given by English seamen.

In the case of Quiros, the circumstances render such falsification impossible. Independent observations, differing slightly from each other, were taken in the two ships of Quiros and Torres. They parted company suddenly and unexpectedly. Torres wrote his 'Report' from Manilla, and gave courses and twelve latitudes. At about the same time, Quiros (in Torquemada) wrote his statement at Mexico, giving dates, courses, and eight latitudes. Torres supplies Burney with the materials for calculating two longitudes. Arias gives three latitudes, and there is another in the 'Auto de Posesion.'

These observations of different observers agree quite near enough to show the approximate route, but differ sufficiently to prove that they were taken independently.

NOTE ON THE IDENTIFICATION OF LA SAGITTARIA OF QUIROS.

By Rear-Admiral Sir W. J. L. WHARTON, K.C.B., F.R.S.

In the accounts of the voyage of Quiros and Torres in 1606, it is related that, on February 10 and 11, the Expedition touched and landed on an island called, by Quiros, La Sagittaria, the southern end lying in lat. 18° 10′ S. or 18° 30′ S., the northern in 17° 40′ S., and on which they saw many inhabitants.

La Sagittaria has been generally supposed to be Tahiti, but I think that this is a mistake. The only word of description is from Torres, who calls it a low island. Now, Tahiti is entirely mountainous, rising to over 7000 feet. It is impossible to believe that the slopes of the hills would not be visible, even if the peaks were covered; and men sailing, as they had done for fifty days, looking for new lands, would have gone into ecstasies over the beautiful prospect afforded by this lovely island.

The landing is minutely described by Torquemada, a translation of whose account, by Sir C. Markham, I have had the advantage of reading, and is an excellent account of the difficulties of landing on the foreshore of a low reef island, on which the swell beats and

breaks, and boats can only back in to allow men to jump overboard, and struggle to the shallow reef edge, with great chance of being overwhelmed by the successive waves, just as is here related.

Now, Tahiti is nearly entirely surrounded by a narrow barrier reef, through which are numerous openings to the smooth, comparatively narrow lagoon within. No one would attempt to land on this barrier, but would pass through an opening, and land on the quiet beach within. Where there is no barrier reef, the sea beats furiously against perpendicular cliffs.

One of the great desires of the voyagers was water, for which, after landing, they searched. At Tahiti there are numerous streams, and they could be seen from the ships.

The island which the expedition struck appears to me to be probably Anaa, or Chain Island, a southern outlier of the great Tuamotu or Paumotu or Low group. This is a long low atoll, about 20 miles in length, the rim of the lagoon being dotted with an almost continuous chain of islands. It lies between 17° 30′ and 17° 20′, which is quite near enough for the determination of latitude which, with the awkward instruments of those days, they were enabled to make from the deck of a ship in motion. Anaa is 200 miles east of Tahiti, a longitude which suits the meagre reckoning of the expedition just as well as Tahiti itself.

It is related that when they landed they passed through a thick wood, and came to the "other bay of still water which is on the other side of the island." This has been supposed to be the isthmus which joins the two high parts of Tahiti, but it answers better to the low islands of an atoll, the still water they reached being the lagoon. The Tahiti Isthmus is 1½ miles across, and the mountains slope abruptly to it on one side and more gently on the other. It is 100 feet high. From whichever side approached, this isthmus lies at the bottom of wide deep bays. These bays are guarded by coral reefs barely covered, on which it is impossible to land. These reefs passed, on the north side a deep lagoon a mile wide, in which lies a picturesque wooded islet, is crossed to the beach; on the south side is a long and intricate harbour, Port Phaeton, at the head of which is the isthmus.

It is impossible to think that this is the place crossed by Quiros' men. It is, moreover, especially stated that "the sea is joined to that other sea on the other side of the island when it is high tide by a shallow and sandy channel between the two clumps of trees." There is nothing to answer to this in Tahiti, whereas there are numerous passages of this description in a lagoon island like Anaa.

On leaving Sagittaria, another low island was seen three days later, in 16° 15′. Steering to the W.N.W. before the trade wind, there is no such island if they had left Tahiti, Tetarva, the only low island near Tahiti, being not more than 20 miles from it. Moreover, as

this island was north of them, they must, in their further course, have sighted the lofty leeward islands of the Society group, which would lie near their track.

Again, they sighted another low island next day. There is no such island, if Sagittaria is Tahiti.

But if they left Anaa, Makatea, in 16° S., answers to the first island, and Matahiva, in 15° S., to the second.

It may be mentioned that Anaa has always been one of the most thickly inhabited of the Low islands. Not many years ago it contained about 5000 inhabitants, and was the French seat of Government; but a disastrous hurricane, in 1879, created great destruction of both life and property.

If Anaa be Sagittaria, it follows that the various islands seen during the days immediately preceding the visit to the latter are not those which have been generally identified with them. But no difficulty is introduced, beyond the difficulty of picking out which of the numerous low atolls which exist eastward of Anaa are those which were sighted. In this probably no two investigators would precisely agree.

THE NATIONAL ANTARCTIC EXPEDITION.

The Departure of the "Morning."

On Wednesday, July 9, the steam yacht *Morning* sailed from the Thames *en route* for New Zealand, whence, after refitting and taking in stores, she will set out in search of the *Discovery*. The object of sending out the *Morning*, and the course to be pursued by her commander, will be seen from the "Instructions" given below, and from the communication to Captain Scott. The *Morning* has been fitted out entirely on the responsibility of the Royal Geographical Society, and it has been through the persistent efforts of the President, Sir Clements Markham, that the necessary funds have been obtained. Up to date a sum of £23,000 has been subscribed. This apparently large sum is not by any means more than has been actually required for the purchase, reconstruction, and equipment of the *Morning*. After providing for all expenses, including the payment of officers and men for eighteen months, there is a balance of £1800, not too large a margin for contingencies. The ship itself, the *Morgen*—in English the *Morning*—was built specially for strength by the late Svend Foyn, of Tonsberg, in Norway, in 1871, and was thought of as the ship for the main expedition in 1897. Her price was then £6000. After the owner's death her price fell, and in October, 1901, she was bought for £3880. Strong though she was, a ship built thirty years ago, and intended for such hazardous work as battling with the

antarctic ice, required to be thoroughly overhauled. This has been done with complete satisfaction by Messrs. Green, of Blackwall, at a cost of over £7000, so that the total cost of the ship, including new boats, new propeller and shaft, cables, steering-gear, spare rudder, ventilation, furniture, cold-storage room, and other things, is probably not less than £11,000. The testing of the ship for stability and the introduction of ballast-tanks alone cost £500. Very serious repairs had to be made to the engine. Then, of course, there has been a large

THE *MORNING*.

expenditure on carpenter's, boatswain's, and engineer's stores, furniture, provisions, clothing, sledges, ice-saws, and new sails, besides scientific instruments and photographic gear. The wages alone for eighteen months amount to £4371. But the ship is now so strong and well equipped that she is prepared to face anything. Her length is 140 feet, breadth 31½ feet, and depth 16½ feet. Her gross tonnage is 437, and her registered tonnage 297. Besides the coals required for the *Morning* herself, she will be able to take out 200 tons for the *Discovery*, together with ample supplies of such articles as will be most required by the explorers. A freezing-chamber has been built on deck, capable

of taking 100 carcases of sheep in ice, and these it is expected will be supplied in New Zealand without charge. The *Morning* altogether can carry 318 tons of coal besides her deck load, and 107 tons of provisions. She is barque-rigged, has a good auxiliary engine and two boilers, and can steam 8 knots. Her light draught is 15½ feet after and 12 feet forward; loaded, 19 feet after and 17 feet forward. Of course, she had to be thoroughly gutted of her old whaling arrangements, and her whole interior was reconstructed for the special purpose for which she

LIEUT. WILLIAM COLBECK, R.N.R., COMMANDER OF THE *MORNING*.

has been bought. She has a fairly spacious ward-room and comfortable cabins for the officers, while roomy quarters have been arranged for the men, and, as the cooking galley is in close proximity, they are likely to be warm enough amid the cold surroundings of the far south.

While the main object of the *Morning* is, of course, to act as tender to the *Discovery*, still she is well equipped with scientific instruments of various kinds, some of which have been supplied by the Admiralty, including excellent survey instruments, a large photographic equipment, sounding gear, and apparatus for collecting at least the surface

fauna of the ocean. Constant meteorological observations will be taken, and in other respects as far as possible the staff on board the *Morning* will do its best to supplement the work of the *Discovery*. The captain of the *Morning* and commander of the relief expedition is Mr. William Colbeck, a sub-lieutenant in the Royal Naval Reserve, who has had a thorough training in seamanship, has been first officer on board the Wilson liner *Montebello*, and was one of the staff of the Southern Cross Antarctic Expedition, on which he took the observations and drew the charts. Captain Colbeck is thirty-one years of age, and has the entire confidence of those responsible for the expedition. His first officer is Rupert England, aged twenty-six, also an officer in the Wilson Line. The other officers are Edward R. J. Evans, sub-lieut. R.N., of his Majesty's ship *Majestic*, aged twenty-one; Gerald S. Doorly, aged twenty-two, midshipman R.N.R., of the P. and O. steamship *Nubia*; George F. A. Mulock, aged twenty, sub-lieut. R.N., of his Majesty's ship *Triton*. The engineer is J. S. Morrison, aged twenty-nine; the surgeon, George Adam Davidson, who has had several years' practical experience; while there are two youngsters rated as midshipmen, F. L. Maitland-Somerville and Neville Pepper, both prepared to do the work of seamen. The crew consists of eight petty officers, nine seamen, and three firemen. A very large proportion of these have been with Captain Colbeck in the *Montebello*, so that he is thoroughly familiar with their qualifications and character. There will thus be twenty-nine all told on board the *Morning*, every one prepared to turn his hand to any work likely to promote the objects of the Expedition.

The following are the instructions to the commander of the *Morning*:—

1. The President and Council of the Royal Geographical Society have fitted out the wooden ship *Morning* to take out coals and provisions and such assistance as she may require to the *Discovery*, now wintering in the Antarctic Regions, and have entrusted you with the command. As soon as you are able to communicate with the *Discovery*, you are to place yourself under the orders of the officer in command of the Expedition.

2. You have superintended the refitting and provisioning of the *Morning* since last February, and you have been consulted and your wishes have been attended to on all that relates to the complement of the ship's company and to the appointments of officers and men. You will, therefore, start on your voyage well equipped in all respects for the performance of the important service which has been entrusted to you.

3. You are to leave England not later than the second week in July, and, after filling up with coals at Madeira, to proceed to Lyttelton, New Zealand. At Lyttelton you are to refit, make good defects, and fill up with coals and provisions; taking on board special supplies of flour and biscuit, golden syrup, and preserved meat. The President and Council attach great importance to the provision of as large a supply as possible of fresh meat and butter for the *Discovery's* people, and a special ice-house has been built on the upper deck. You are to see that it is well stocked, and that care is taken as regards its management.

4. You are also to give close attention to the dietary, health, and comfort of your own officers and crew.

5. You are to proceed from Lyttelton to the ice in December; and your previous experience of the antarctic pack will enable you to decide upon the best time for entering the ice, and on the meridian which offers the best hope of a speedy passage. On reaching open water to the south, you are to proceed at once to Cape Adare.

6. Copies of a letter from Captain Scott to the Presidents dated December 17, 1901, with an enclosed note by Mr. Bernacchi, and of a despatch from the Presidents to Captain Scott which will be sent out in the *Morning*, are herewith enclosed for your information and guidance.

7. You will see, from Captain Scott's letter, that it is his intention to leave records at Cape Adare, Possession island, Coulman island, Wood bay, Franklin island, and Cape Crozier. You will, therefore, search all these places, or such as you are able to reach, for records, your searches being guided by the information respecting the exact localities where the records are to be deposited, contained in Mr. Bernacchi's note.

8. You are also to examine the coast from Cape Adare to Cape Crozier with great care, to find the *Discovery* in the event of her having wintered anywhere between those points.

9. In the event of finding the *Discovery* anywhere on the east coast of Victoria Land, you should use your best endeavours to communicate, to assist in extricating her from her winter quarters, and to transfer the coals and provisions. You will then proceed as directed by Captain Scott.

10. If you are satisfied that the *Discovery* has not wintered on the east coast of Victoria Land, you are to proceed eastward along the ice-barrier to the place where you landed in February, 1900. Here it is the intention of Captain Scott to endeavour to leave a record on the ice.

11. The absence of the *Discovery* from any part of the east coast of Victoria Land will no doubt lead you to the conclusion that she has succeeded in penetrating into the unknown region to the eastward of the 164th W. meridian.

12. In that case you are not, under any circumstances, to follow her. But, in compliance with Captain Scott's wishes, you are to endeavour to form a depôt consisting of two months' provisions at Cape Crozier, a large depôt of coals and provisions in Wood bay, and a depôt of two months' provisions at Cape Adare. You are not to risk detention in the ice, but you are to make the best of your way to Lyttelton while it is possible, and there await further instructions. You should reach Lyttelton in March or April, 1903.

13. The records left by Captain Scott, which you may succeed in finding, may contain instructions with regard to your procedure, which are not in agreement with those now given to you. In that case you are to obey Captain's Scott's instructions in preference.

14. You will be careful to leave at the places at which you touch records of your proceedings, together with copies of these instructions and of the letter to Captain Scott, for which purpose several spare copies will be supplied to you.

15. The *Morning* is a yacht in the list of the "Royal Corinthian Yacht Club," and is registered under the Merchant Shipping Act, 1894, the Royal Geographical Society being owners. You will see that all on board sign the ship's articles as required by the Act.

16. You are to take every opportunity of acquainting me with your proceedings and your requirements.

17. You have already acquired experience in the navigation of the antarctic seas, and the President and Council have every confidence in your zeal and ability

as a seaman, and that you will carry out these instructions with care and satisfaction. The duty entrusted to you is one of great difficulty and of great importance. You may rely upon the support of the President and Council, and you may assure your officers and crew that the owners of the *Morning* will appreciate their labours, and will watch over their interests while absent on their arduous and difficult service.

(*Signed*) CLEMENTS R. MARKHAM,
President R.G.S.

The following is the "Letter to the Officer Commanding the National Antarctic Expedition":—

1. Our last letter to you was dated October 29, 1901, and we have since received from you your letters of proceedings No. 3 (November 28, 1901), No. 4 (December 22, 1901), and No. 5 (December 24, 1901). We have also received and considered your letter on the subject of the relief ship, and of the instructions her commander should be given, dated December 17, 1901. Your letters to Mr. Longhurst, chiefly relating to the wages and allotments of the men, have all been received and duly attended to; and Mr. Waymouth has sent in an account of the sale of stores left by you at Lyttelton.

2. The magnetic observations and deep-sea sounding reports, and the specific-gravity observations, have been taken charge of by the Hydrographer; and the meteorological observations by the Meteorological Office. The rain-gauge observations were first submitted to Dr. Black, of Edinburgh, in accordance with the wish expressed by Lieut. Royds, and the observations specially taken at the suggestion of Prof. Letts have been forwarded to that gentleman at Belfast. The biological and botanical collections arrived in excellent order, and have been entrusted to the Director of the Natural History Department of the British Museum, together with Dr. Wilson's sketches. The geological specimens were submitted to Mr. Teall, the Director of the Geological Survey.

3. The Trustees of the British Museum have offered to receive all the collections made by the Expedition, to work up the specimens, and to publish the results in a suitable manner, with the funds entrusted to them for such purposes by the Government. The work will be edited by the Director of the Natural History branch of the British Museum, the collectors receiving full credit, and being probably employed as sub-editors. This proposal of the Trustees appeared to be advantageous, and has been accepted by us.

4. From the latest letters received from you we learn, with great pleasure and satisfaction, that you consider the Expedition to have been completely equipped, and that all on board the *Discovery* are animated with that zeal for the service on which they are employed, and that loyalty to yourself as their commander, which can scarcely fail to ensure successful results. We have endeavoured to perform our part by attention to the interests of the members of the Expedition, and by our efforts to comply with the wishes and to forward the views contained in your letter of December 17, with reference to the despatch of a relief ship.

5. You are already aware that a Norwegian wooden ship has been purchased. She has now been refitted at considerable expense, and will commence her voyage to New Zealand early in July, under the command of Mr. William Colbeck, R.N.R., a gentleman with whom you are already acquainted, and who has knowledge of navigation in antarctic waters. The *Morning* is capable of carrying 300 tons of coals, apart from a deck load, 150 or 200 of which would be for the *Discovery*. Besides coals, she can carry about 100 tons of provisions, and she also takes out

some warm clothing for the *Discovery*, especially komagers. Mindful of the wish expressed in your letter of December 17, an insulated freezing-room has been built on the upper deck of the *Morning*, calculated to contain a hundred carcases of sheep, or 6000 lbs. of fresh meat. It is intended to obtain a large proportion of the provisions and coals at Lyttelton, and care has been taken to send out flour, golden syrup, preserved meat, and butter, the kinds of supplies mentioned by you, as per schedule at the end of this letter. The relations of all on board the *Discovery* have been informed respecting the despatch of letters and parcels by the *Morning*. We enclose a copy of the instructions to Captain Colbeck, with detailed list of her officers and crew.

6. Judging from the instructions, and from your intentions so far as they have been made known to us, the most probable event connected with the Expedition is that the *Discovery* will have wintered in Wood bay, or at some other point on the east coast of Victoria Land. Captain Colbeck is instructed to enter the pack in December, or in the first week of January, 1903, and as soon as he reaches open water, to examine the positions enumerated in Mr. Bernacchi's note (which forms an enclosure to your letter of December 17, 1901), in search of records. As soon as he finds the *Discovery* he is to communicate, and to place himself under your orders.

7. You will then be in command of the two ships, and you are to take what you require from the *Morning*, and extricate yourself from your winter quarters with as little loss of time as possible. You are then to do as much exploring and scientific work as the time will admit with the two ships, during the navigable season of 1903. The direction you will take, and the methods you may adopt in performing this service, are left entirely to your own discretion. You will return to Lyttelton in March or April, 1903.

8. An alternative event is that you have succeeded in navigating the *Discovery* far beyond the most eastern point reached by Sir James Ross along the ice-barrier. In that case it is probable that you would make your way eastward, coming out of the ice somewhere in the Ross Quadrant. You advise that, in this event, the *Morning* should not be instructed to follow you. Only in the event of disaster is it likely that your retreating parties would return to Victoria Land. If, therefore, the *Discovery* is not found on the east coast of Victoria Land, Captain Colbeck is instructed, in accordance with the desire expressed in your letter of December 17, to establish depôts containing two months' provisions at Cape Adare, and the same quantity at Cape Crozier, and to leave a large supply of coals and provisions in Wood bay.

9. There are other possible courses that events may have taken which we, in England, can neither foresee nor provide for. Much must, therefore, be left to Captain Colbeck's discretion.

10. We are aware that you were, and probably still will be, very anxious to continue your exploring and scientific work after your return to Lyttelton, during a third navigable season. This would certainly be very desirable if the funds are sufficient.

11. As at present informed, we are of opinion that a third season is not feasible from a financial point of view. But matters may have a different aspect in April, 1903, and we shall be in communication with you on these points when you return to Lyttelton.

12. But, as now advised, we think that the work of the Expedition cannot be prolonged to a third year. As soon, therefore, as the members of the Expedition have been sufficiently rested and refreshed at Lyttelton, you are to proceed to the Falkland islands, taking a series of magnetic and other observations, and deep-sea

soundings across the Pacific, in as high southern latitudes as you can traverse with safety, and thence home.

13. In conclusion, we desire to express our confidence that you and all under your command have zealously and energetically done your best to secure all the objects of the Expedition. His Majesty the King has expressed anxiety to have any news communicated to him that may, from time to time, be received regarding the Expedition. And from His Majesty downwards, all classes in this country have shown the interest they take in the welfare of their antarctic explorers. We all look forward anxiously, but hopefully, for news of your safety.

(*Signed*) WILLIAM HUGGINS,
President R.S.
CLEMENTS R. MARKHAM,
President R.G.S.

Thus it will be seen that every contingency has been provided for as far as possible, but the circumstances may be such as to call for independent action on the part of Captain Scott or Captain Colbeck, or both. But there is perfect confidence in the intelligence and judgment of both commanders. In his last report Captain Scott more than once asserts that no anxiety need be felt if the *Discovery* is not met with; it will probably mean that the progress of the Expedition has been much more successful than was expected. In that case of course the *Morning* will return to New Zealand, and it is possible that the *Discovery* might come out of the ice independently, perhaps on the American side. If she did not, of course the *Morning* would return to look for her in the following antarctic summer. But for the present we may be satisfied that all has been done that possibly could be done, and we can only wait with patience till the spring of next year, when we may expect to receive news of the Expedition.

THE RUSSIAN POLAR EXPEDITION.

SUMMARY REPORT FOR 1901.

By BARON ED. TOLL.

ON April 18, 1901, immediately after the Feast of Easter, Lieut. Kolomiezoff and the zoologist, A. Birulja, set out with two sleighs, each with a team of eight dogs, the object of the first being to reach the Yenisei and establish coaling stations, while the second was directed to accompany it as far as Cape Sterlegoff, some 200 versts distant. Two days later began my excursion with Lieut. Koltschak to the Chelyuskin peninsula, accompanied by a sleigh with a team of twelve dogs, and laden as lightly as possible.

On May 1 we reached that point on the bay where we had established a depôt the previous year (1900). The provisions and

fish here buried were to complete our supplies, which barely sufficed for just one month. But we were unable to dig out the deposit from the deep snow.

On May 7 we started from this place in an east-north-easterly direction, with the intention of pushing on to St. Thaddaeus bay on the east coast of the Chelyuskin peninsula, and returning thence along the coast. After traversing the tundra for 40 versts in this direction, we again came unexpectedly on an inlet, which grew narrower towards the west-south-west, where it assumed the form of a narrow sound or river-mouth. The position as determined by Lieut. Koltschak on the off side of the bay was 76° 17′ N. and 99° 29′ E.

On May 12 we gave the tired dogs a day's rest at a place fixed by Lieut. Koltschak at 76° 20′ N. and 101° E. Thence I made a day's march, half a degree eastwards, on Canadian snow-shoes. The prospect of any successful hunting was very slight, while our supplies were becoming seriously less, and could no longer hold out for more than eight days. Hence nothing remained but to retrace our steps. Hitherto we had to contend with almost constant difficulties caused by fog and the deep snow already softened by the sun. But henceforth we had to struggle with contrary snow-storms, which lasted almost without a break for fourteen days. The consequence was the loss of five dogs which broke down one after the other through exhaustion. On May 30 we reached the *Sarya*, the excursion having lasted forty-one days. Of these we had to pass nine in the sleeping-sack during the fiercest snow-storms; four were uselessly wasted at the depôt; and during the remaining twenty-eight days we covered 500 versts, the routes surveyed by Lieut. Koltschak being determined by nine astronomical observations. At the *Sarya* I found all the members of the expedition in good health, except Dr. Walter, who was suffering from rheumatism of the joints. But he was otherwise well, and soon regained his full strength.

A. Birulja was back by May 6, after accompanying Lieut. Kolomeizoff as far as Cape Sterlegoff, 75° 29′ N. and 89° 25′ 24″ E. He made an accurate compass survey of the section of the coast traversed.

The day before my return, A. Birulja, together with F. Seeberg, a member of my excursion, had gone off on a trip in the district of the *Sarya*, their objective being a mountain which was 35 versts distant from the winter harbour. As it was the highest point in this coast region, his intention was to place a minimum thermometer on the summit. At the same time Birulja carried out a topographic survey of the intervening tract, while Seeberg made local astronomical determinations and magnetic observations. On June 7 both savants were again on board the *Sarya*.

Meanwhile summer was rapidly drawing nearer. At the end of June was opened the first great crevice in the ice of the *Sarya* roadstead, about 2 versts from the ship. The surface ice which, during the

winter, had increased to a thickness of 1·82 meter, grew daily thinner, melting away from the surface downwards. Hence we expected that at the beginning of August the *Sarya* would be released from her winter fetters. But in the interim there was still to be solved a geographical question, namely, to discover the mouth of the Taimyr river.

According to the maps hitherto published, the Taimyr was supposed to discharge in the first or the second of the larger bights lying to the east of the Taimyr sound. Both of these were twice explored by Lieut. Kolomeizoff, and in the first was, in fact, found the mouth of a considerable stream; but its configuration was not at all in accordance with the contour lines given by the topographer Wagenoff on Middendorff's chart. In the second bay no indication could be detected of any river-mouth. As these researches had been undertaken in winter amid fogs and snow-drifts, there still remained a doubt, which could only be removed by fresh investigations carried out in clear summer weather. Should these also lead to negative results, the only remaining assumption would be that the Taimyr discharged into that bight which, during our journey to the interior of the Chelyuskin peninsula, Lieut. Koltschak and I had crossed, since no considerable stream assuredly entered that other inlet where the depôt lay.

The survey of the first two bays was now undertaken by Birulja and Dr. Walter, while I decided to proceed with Seeberg to the farther inlet. As dogs are not available for travelling in this season of the year, there remained only one possible plan, that was for ourselves to take in tow the sleigh, on which a kayak had to be conveyed.

The excursion of Birulja and Dr. Walter lasted from July 20 to August 15, 1901. Respecting the question of the mouth of the Taimyr, the two savants came to negative results. Still, they confirmed Kolomeizoff's discovery of a large estuary in the first of the two bays. Seeberg and I left the *Sarya* on July 18. The bay which formed the objective of our journey was completely free of ice, and after visiting Baer island, which lies in the bay, we were able to certify that this inlet is the mouth of the Taimyr river. On August 24 we were again on board the *Sarya*.

Next day a stiff east wind sprang up; the fissures in the ice of the roadstead expanded; the whole of the ice-pack round about the *Sarya* was set in motion. We drifted first right in the direction of the cliffs of Station island, and then the ice trended to the right clear of the island. We were slowly carried beyond the island, and after six hours the *Sarya* was driven through the Fram strait into the open sea.

During the night we reached the little island at which the previous year further progress had been arrested by a strong ice-barrier. Now, also, the barrier stood firm, and prevented our getting through. We therefore withdrew behind a cape at Nansen island to await the drifting

away of the ice-pack. On August 30 the water-way was free, and the *Sarya* began its voyage. On September 1 we doubled Cape Chelyuskin On September 4 we sighted the east coast of the Taimyr peninsula, and then set our course straight for Kotelnoi island.

Without meeting any ice we drew near the New Siberian archipelago in favourable weather till September 7, when a strong south-easter began to blow in our teeth, and against this we made very slow headway. I therefore changed the course to the north-east. On September 9 we reached the edge of the pack-ice in 77° 9′ N. and 140° E. Here we encountered a southern gale, which, acting in concert with the marine current, drove the *Sarya* 30 miles to the north-west. The storm veered round to west-south-west, and I thought it better again to make the most of the wind and now direct our course south-eastwards for Bennett island, instead of trying under these circumstances to penetrate into the ice in search of land. On September 11 the imposing headland of Cape Emma at Bennett island suddenly loomed up before us out of the fog, and presently became again wrapped in fog.

We had approached to within 12 knots of the island, when our further advance towards it was barred by a belt 14 feet thick of impenetrable pack-ice. Here we remained two days in the hope that the ice might shift, but in vain! Yet the engine was in urgent need of repairs; the boiler wanted cleaning, and the pumps putting right. But here no landing was possible, and no option was left but to return. I wanted again to make for the point from which we had been driven by the storm, and accordingly directed the course along the ice-fringe, first westwards, and then north-westwards. In this direction we reached 77° 32′ N. and 142° 17′ E., but had then to yield to the ice bearing down from the north to avoid being closed in. Now I gave orders to steer for Kotelnoi island, and on September 16 we cast anchor in Seal bay, where we were received by K. A. Wollosovich, leader of the rescue expedition. On September 24 the *Sarya* was ready to set sail; but on that day the temperature of the atmosphere was 21·7 F., and of the water 30·2 F., and the drift-ice was forming a continuous crystallization round about the vessel. On this day the second wintering had begun, after a period of thirty days' open navigation.

The station where the hourly observations had begun, on November 1, 1901, was erected under more favourable conditions this year than in the preceding. The accumulations of drift-wood at the bar on which the station stands made it possible to build the necessary structures of wood instead of snow. They moreover yield us such an abundance of fuel that we are all able to keep our living-rooms and the laboratory warm and dry, which will certainly have a favourable influence on the crew, and the same may be said of the now finished Russian vapour-bath. It is further of great importance that we are provided with fresh reindeer meat for the whole winter.

REVIEWS.

AMERICA.

Central America.*

In the *Journal* for February, 1901, a notice appeared of Frau Seler's 'Auf alten Wegen in Mexico and Guatemala,' containing a popular account of Prof. Seler's expedition of 1895–97 to Central America, undertaken at the instance and at the charge of the Duc de Loubat in the interest of archæology and ethnography. In the present volume are embodied the scientific results of a long visit paid on that occasion to the secluded and hitherto almost unknown district of Chaculá, in the Guatemalan department of Huehuetenango, on the frontier of the Mexican state of Chiapas. The discoveries here made proved to be of quite exceptional importance, and so numerous were the monuments surveyed and the objects found in them and in the neighbouring limestone caves, that no less than 50 photographic plates and 282 inset figures and plans have been required to reproduce and illustrate them adequately. The volume, which is of quarto size and printed in bold type on stout paper, is further equipped with a large sketch-map of the district and a very fine map of the surrounding South Mexican and Central American lands.

Chaculá itself is at present a mere hacienda, or farmstead, standing about 5260 feet above sea-level in a thickly wooded, hilly tract which presents geological features analogous to the calcareous Karst formation of the Balkan peninsula. Although now almost uninhabited, except by a few Indians of the Maya-Quiché family, there are abundant indications in the groups of remains scattered over a wide area that the whole district was at one time densely peopled by settled and more or less civilized communities allied to the cultured inhabitants of Palenque, Coban, and the other ancient cities of Chiapas and North Guatemala. These all belonged to the same Maya-Quiché connection, and the remains of all kinds unearthed and examined by Prof. Seler, while often showing interesting signs of independent local developments, present on the whole the same general features as those of the Maya as distinguished from the Aztec types.

This is true, not only of the objects brought to light at Chaculá itself, but also of those found in the Uaxac canal valley, in the Yalambohoch woodlands, in the Cueva de los Pájaros, amid the crumbling monuments of the ancient settlement of Quen Santo with its Temple of the Sun and numerous caves, and in all the other localities visited by the author. Thus the symbols of the Yucatec water-goddess, *th bolon ts'acab*, were recognized on the stone at Cimarron. The god figured on the Piedra redonda near the same site was identified as the Maya god *Oxlahun tox*, the deity of the West, the war-god worshipped by all the Maya peoples, but unknown to the Aztecs, unless he can be brought into some kind of relation with the terrible Tezcatlipoca, called also Yaotl, the "warrior."

But there are, of course, many points of contact between the two cultural systems, and Prof. Seler describes the sites and ground-plans not only of temples, palaces, and pyramids, but also of several *tlachtli* ("tennis-courts") which still exist in the Chaculá district, and correspond in their main features with those already described by himself and other observers both in Mexico and Mayaland. The Mexican enclosures are, as a rule, in a much more dilapidated state than those of Yucatan and Guatemala, and it is interesting to note that from a careful study

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* 'Die alten Ansiedelungen von Chaculá . . . Guatemala.' Von Dr. Eduard Seler. Berlin: 1901. 'Mittelamerikanische Reisen und Studien aus den Jahren 1888 bis 1900' By Dr. Karl Sapper. Brunswick: 1902.

of the latter he has been able to clear up the Aztec text of Sahágun, who describes the Mexican ball-courts in somewhat vague language. He has much to say on this subject, and we are here reminded that the rubber ball was tossed, not with the hands or feet, but with hips and shoulders, just as Mr. A. R. Wallace tells us the game is still played by the Papuans in some parts of Malaysia. So much for like usages as a test of racial affinities and contacts.

From the general character of the objects found amid the ruins, in the caves and graves—plain and decorated earthenware, clay masks, stone figures of men and animals, musical instruments of human bones, carved stelæ, incense-burners, rattles, and the like—it is evident that the Chaculá people had made less progress in the arts than the kindred Mayas of Chiapas and Yucatan, whose civilization is represented by the great monuments of Palenque, Coban, Uxmal, Chichen-Itza, Copan, Quiriguá, and the other ancient cities of Central America. By means of the fragments of two inscribed stelæ now embedded in a wall at Sacchaná, but originally from Quen Santo, Prof. Seler essays to determine the approximate date of the Chaculá settlement. These are compared with the hieroglyphs sculptured on the stele M of Copan, to which they are strictly analogous, although more clumsily executed and much more weather-worn. From an elaborate study of these documents, and on the now established principles of the Maya calendric system, it is inferred that all the known Maya monuments, those of Chaculá included, and the temples of Palenque alone excepted, were erected within a period of a few centuries before the discovery. Specialists will find much to interest them in this long essay on Central American chronologies, and some will be surprised to find that the Katunic cycle, for instance, was not 20 years long, as stated by the early writers, nor 24 years, as held by Mr. Cyrus Thomas, but 20 × 360 days, or 19 years + 265 days, the solar year being reckoned at 365 days without bissextile or other intercalary corrections. Needless to say that the seven week-days of Bishop Nuñez de la Vega, corresponding to "the seven planets of the Gentiles," are here also finally disposed of. As the author states emphatically, "Of such a week nothing was known in ancient Mexico or elsewhere in Central America" (p. 95). The more the salient features of the native systems are subjected to critical analysis, the more they are found to diverge from those of the Old World, thus plainly showing that the various civilizations of the aborigines were locally developed independently of all extraneous influences. Were any further proof needed to establish the intimate connection of the Chaculá culture with that of the surrounding Maya populations, it would be supplied by the hieroglyph of the planet Venus, which Prof. Seler found inscribed on a stone at Quen Santo exactly as it occurs on the monuments of Copan and Chichen-Itza and in the still extant Maya pictorial documents.

It should be mentioned that this volume is the first of a series in which the gifted author proposes to work up the rich materials collected by him during his memorable expedition of 1895–97 to Mexico and the Maya lands.

No name has in recent years been more prominent than that of Dr. Sapper in connection with the geographical and economic relations of the Central American States. A sojourn of over twelve years in the Isthmian regions entitles him to speak with some authority on these relations, and the two volumes in which he has given permanent form to his impressions and experiences must be accepted as valuable contributions to our knowledge of these volcanic lands and their turbulent inhabitants. In the first book—'Das Nördliche Mittelamerika,' Brunswick, 1897—was embodied a great mass of valuable information on the southern parts of Mexico and the conterminous states. The second, here under notice, forms a direct sequel and complement to that work, covering the whole of Central America

properly so called, from South Guatemala and British Honduras to Costa Rica inclusive. It is by no means a systematic treatise, and the form in which its copious materials are thrown together betrays little regard for the requirements of the general reader. The absence of an index is poorly compensated by a very meagre table of contents, with no numbered chapters, but only a few short headings disposed in two parts, which are not even indicated by any special typographic device, but run together in the body of the text. There is, however, a complete list of the sixty photographic illustrations, which add greatly to the value of the book, some being of very large size, folding in like maps, while all are clearly reproduced by the new processes brought to such perfection in Germany. Quite a panoramic view is thus presented of Antigua, for instance, with its dangerous neighbours, the "Fire" and "Water" volcanoes; of the city of Guatemala; of the Cerro del Tigre in Fonseca bay; of San José, capital of Costa Rica; of Bocas del Toro and its harbour; of the coast district near Aspinwall; and of the flourishing coffee plantations at Coban. Equally welcome are the four large-scale biogeographical maps, one of which shows a new departure in diagrammatic cartography. It must prove of great value to travellers and intending settlers, showing at a glance for the whole region between Tehuantepec and Panama the time required to traverse any given measured distance, this varying from one to as many as fourteen days according to the physical character of the district, the state of the highways, and so on. Hence its name, "Isohemerenkarte," *i.e.* Isohemeral Chart, or, in plain English, Map of Timed Distances.

The first and larger section of the volume is entirely occupied with the various expeditions undertaken from time to time to all parts of the country. But what the descriptions thus necessarily lack in coherence and unity they gain in the charm of a simple unaffected style, and especially of a genuine sympathy with the people and their primitive ways. Volcanic eruptions and earthquakes are welcomed as affording opportunities for scientific investigations "on the spot;" political revolutions break out to clear the atmosphere, or *zur Abwechslung*, "by way of change;" even the interminable hecklings of inquisitive natives are endured with exemplary patience. When about to ascend the Cerro del Tigre, he is asked, "Why do you want to clamber up this mountain?" "And wherefore?" "And for what reason?" "And for what purpose?" "And what do you expect to find up yonder?" "A gold-mine perhaps?" And so on, until the traveller is driven almost mad, and begins himself to wonder why he wastes "so much time and money in such unprofitable studies."

In the second part a measure of unity is given to the volume by the opening sections, in which are ably summed up the results of his observations on the geography, the geology, natural history, and ethnology of the whole region. These are followed by some remarks on the rival Panama and Nicaraguan ship-canal projects, and by a series of essays on the natural resources of the country, the prospects of the coffee, rubber, and indigo industries, with practical suggestions on the laying out of plantations, rainfall records and statistical tables, agricultural and commercial, for all the Central American States.

A. H. K.

OCEANOGRAPHY.

The Voyage of the "Gauss."

The newly founded Institute of Oceanography and the Geographical Institute of the University of Berlin, both presided over by Baron F. von Richthofen, have

issued the first part of their publication,* and devoted it to an account of the first stage of the voyage of the German Antarctic Expedition. Baron Richthofen gives an introductory account of the Institute of Oceanography, the functions of which are (1) to maintain an oceanographical museum in which naval, commercial, historical, and scientific exhibits are to find a place, (2) to promote scientific work, (3) to afford instruction, and (4) to improve the knowledge of marine matters and increase the interest in the sea and all that concerns it throughout Germany. The German Antarctic Expedition, which is under the direct auspices of the Government, sends in its reports to the Imperial Department of the Interior, and that department has made them over for publication to the allied "institutes" of the University of Berlin. There has been no delay in so doing, for this report was published in March, and the *Gauss* only reached Cape Town at the end of November.

The report naturally contains nothing about the Antarctic regions, but furnishes a full account of the preliminary training in scientific work at sea by which the members of the expedition have fitted themselves to deal with the new problems of the far south. There are four divisions of the report, viz. I. General narrative of the voyage as far as Cape Town, by Prof. Erich von Drygalski, leader of the expedition. II. Scientific Reports, including (1) description of St. Vincent in the Cape Verde group, by Dr. Emil Werth and Dr. Emil Philippi; (2) oceanographical observations, by Prof. v. Drygalski; (3) the estimation of salinity by chemical processes, by Dr. Philippi; (4) the oceanic deposits, by Dr. Philippi; (5) bacteriological investigations, by Dr. Gazert; (6) biological observations, by Dr. E. Vanhöffen; and (7) magnetic observations, by Dr. Friedrich Bidlingmaier. III. Technical Reports on the ship and navigation, by the chief engineer, Albert Stehr, and Captain Hans Ruser. IV. The Kerguelen Station, by Dr. J. J. Enzensperger.

After leaving the Cape Verdes on September 20, the *Gauss* shaped a southern course with the object of first investigating the great depth reported in 1883 by the French man-of-war, *La Romanche*, near the equator in 18° W., and then visiting the island of Ascension in 14° W. The former object was successfully accomplished, a sounding of 3950 fathoms was obtained in lat. 0° 11′ S. and long. 18° 15′ W., thus completely confirming the great depth which has not hitherto been recognized on official charts. This sounding proves that the East Brazilian depression stretches further to the north-east than was formerly supposed; and the sample of the deposit brought up suggests some entirely new evidence as to the earlier distribution of land and water in the Atlantic area. But on advancing southward the *Gauss* met a freshening south-east trade wind and a strong westerly current, the struggle against which, in the direction of Ascension, shortened each day's run in a disquieting fashion, and at length Prof. von Drygalski deemed it better to abandon the call at Ascension and take advantage of the trade wind by steering south by west. The farthest west was about 21° W. in 24° S., from which point an easterly sweep brought the ship to Cape Town on November 23. On comparing the route and dates with those of the *Discovery*, we see that from 40° to 10° N. the track of the *Gauss* was nearly parallel to that of the *Discovery*, but a few degrees further west; from 10° N. to 26° S. the track of the *Gauss* was alternately a few degrees east or west of the meridian of 19° W., while the *Discovery* took a great westward curve to about 36° W. before reaching Trinidad. The *Gauss's* track eastwards to Cape

* Deutsche Südpolar-Expedition auf dem Schiff "Gauss" unter Leitung von Erich von Drygalski. Bericht über die wissenschaftlichen Arbeiten auf der Fahrt von Kiel bis Kapstadt und die Errichtung der Kerguelen-Station, mit Beiträgen von Bidlingmaier, v. Drygalski, Enzensperger, Gazert, Philippi, Ruser, Stehr, Vanhöffen, Werth. Berlin: Siegfried, Mittler und Sohn. 1902.

Town was a few degrees north of the parallel track of the *Discovery*. The *Gauss* passed the Lizard and Madeira a fortnight later than the *Discovery*, she crossed the equator a month later, and reached Cape Town seven weeks later. Deducting the time spent in making observations and considering the less favourable route adopted, the speed of the *Gauss* under sail would appear to be a little, but not very much, less than that of the *Discovery*.

So far as can be judged, the most interesting and valuable results of the Atlantic voyage of the German Expedition would appear to be the thirty deep-sea soundings which were taken at carefully selected points, and the biological work, especially the collection of plankton. The magnetic observations at sea may also prove of value, but they will require to be critically discussed before that can be decided. In magnetic work more than any other is it necessary for the observer to become accustomed to the difficulties of observations at sea, and Dr. Bidlingmaier refers feelingly to the difference between the solid stone pillars on which he was accustomed to rest his instruments in the laboratory on shore and the swinging table which has to be used on board ship. A number of determinations of the magnetic elements were made on board, and at Cape Town these were repeated on shore and compared with the Cape instruments, which a few weeks previously had been compared in the same way with those on the *Discovery*.

In addition to the verification of the deepest equatorial sounding known in the ocean, the *Gauss* succeeded in securing fourteen soundings in depths greater than 2500 fathoms. The most southerly sounding in 35° 52′ S., 13° 8′ E., gave a depth of 2750 fathoms, and a long core of the deposit, which was found to consist largely of fine quartz sand. Though within 200 miles of the extreme south of Africa, this sand does not appear to be an extension of the terrigenous deposits bordering that continent, for a shallower sounding very much nearer land revealed a pure globigerina ooze. It is suggested that the sand must have been carried by antarctic icebergs.

It is unnecessary to refer to the trials and comparisons of the various instruments and processes which are described in the report further than to say that the experience of the action of thermometers and townets in tropical waters will have to be revised in the light of similar experience in the polar sea before their suitability or unsuitability can be decided upon. Comparisons of methods of salinity observations are different, and the *Gauss* is very richly supplied with apparatus for alternative methods, including a refractometer and the total immersion hydrometers, on the exceptional value of which Dr. Nansen speaks strongly in his treatise on hydrometers in connection with the results of the *Fram* Expedition.

H. R. M.

THE MONTHLY RECORD.

EUROPE.

Sir John Murray's Survey of the British Lakes.—Considerable progress has already been made with the survey of the British lakes, which is being carried out under the superintendence of Sir John Murray. Since the beginning of April, with the aid of Dr. T. N. Johnston, Mr. James Parsons, Mr. James Murray, and others, twenty lakes had been surveyed before the end of June, chiefly in the basins of the Tay and Spean, the investigations embracing, in addition to the determination of the under-water contours, observations on the temperature-gradients, transparency, bottom deposits, and the microscopic organisms contained in the water. Of the twenty lakes surveyed, only four appear to have been systematically sounded before, viz. Lochs Tay, Earn, Rannoch, and Tummel, which had been examined

by Mr. Wilson, of the Geological Survey (Loch Earn also by Sir John Murray and Mr. Pullar). Mr. Wilson's results are, on the whole, confirmed by the recent surveys. The largest lake sounded is Loch Tay (14½ miles in length), the maximum depth of which was found to be 503 feet, and the mean depth 199. The lake forms virtually a simple basin, the portion over 500 feet in depth lying somewhat to the north-east of the centre. There are, however, two areas enclosed by the 300-feet contour, the smaller, which does not reach 400 feet, lying about 3 miles from the south-western end. The proportion of the whole area exceeding 300 feet is 25 per cent., 45 per cent. having depths from 100 to 300 feet, and 30 per cent. under 100. In Loch Tummel (2¾ miles long) the greatest depth found was 128 feet, and the mean 48. There are three basins separated by shallower water, the deepest being near the west end of the lake. In the central basin the greatest depth is 119 feet, and in the eastern 99. Only 10 per cent. of the whole exceeds 100 feet in depth, while 37 per cent. has less than 25 feet. Loch Laidon, which, apart from its western arm, has a length of 5⅓ miles, was found to have the same maximum depth as Loch Tummel, though the mean depth is only 35 feet. In its centre there is an area three-quarters of a mile long with depths exceeding 100 feet, while two or three isolated soundings of more than that amount were found outside the main 100-feet contour. The western arm is shallow and rocky, no greater depth than 17 feet being found here. Of the whole area only 4 per cent. has greater depths than 100 feet, 53 per cent. of the lake-floor being covered with less than 25 feet of water. Of the upper lakes which drain into Loch Laidon, and which lie among glacial moraines in the Black Forest, the largest, Loch Bá, is somewhat over 2 miles long. All are shallow, and the larger ones are irregular in outline and studded with islands. Loch Bá has a maximum depth of 30 feet, and the others of the group are still shallower. Loch Lyon, though only about 1¾ miles long, is fairly deep (maximum 100 feet, mean 45 feet). The deep water lies much nearer the south-western than the north-eastern end; 22 per cent. exceeds 75 feet, half the remainder being deeper and half shallower than 25 feet. Loch Tulla, with a length of 2½ miles, is somewhat shallower than Loch Lyon, the maximum being 84 feet, the mean depth 38; 32 per cent. of the area exceeds 50 feet, and 37 per cent. has less than 25. The main depression lies north-east of the island of Eilean Stalcairichd. Loch Treig (over 5 miles long), of the enormous depth of which many random statements have been made, was found to form a simple basin, 436 feet at its deepest point, in which water over 400 feet in depth extended through a length of nearly two miles about the middle of its length. The mean depth is about 207 feet, and 25 per cent. of the whole exceeds 300 feet. The seiche observed on this lake has already been alluded to in the *Journal*. Of the other lakes sounded, Loch Ossian has a maximum depth of 132 feet, and a mean depth of 42¾ feet, while only 5 per cent. of its area exceeds 100 feet.

The Laufenburg Rapids.—The morainic deposits of the last glacial period covered the old valleys of Northern Switzerland, and the rivers have cut out their beds in these deposits. In many cases they have not found the old bed, and before reaching its level have passed through the morainic terraces to the underlying rock, which is harder to erode. Here rapids are formed, of which that of Laufenburg is an excellent example. The Laufenburg rapids are in gneiss, and extend for some 1300 metres, with an average width of 75 metres, which is reduced to 12 metres at mean water, where a granite dyke crosses the bed at right angles to the river axis. Mr. H. Walter has made an elaborate survey of the region. His maps, sections, and notes have been deposited in the library of the Naturforschende Gesellschaft of Zürich. They will prove most precious documents for the future study of these

rapids, and will permit an accurate estimate of denudation if an equally careful survey is made on the same plan a generation hence. A summary of the results, with maps, sections, and views, is given in the *Vierteljahrsschrift* of the Zürich Naturalists' Society (46, 1901). The following table shows the speed of the river at different sections of the rapids during the flood of June 13, 1876.

Kilometres.	Area of cross-section. Square metres.	Speed. Metres per sec.
0·442	1558	3·34
0·551	2106	2·47
0·991	910	5·52
1·442	980	5·31
1·600	2200	2·37
2·548	2060	2·57

Hence the speed is approximately inversely proportional to the cross-section. The difference between the highest and lowest water-level at the bridge at Laufenburg is 17·11 metres. The volume of water passing per second in time of flood may rise to over 5200 cubic metres. In winter it averages about 740, in summer 1235, and the mean of the year is 980 cubic metres per second. The minimum observed is 265 cubic metres per second. Even at the highest flood the erosion is not great, owing to the waters of the Rhine and its most important tributaries having been filtered in lakes, but pebbles exist at the bottom of the river, while the sides of the gorge are rugged owing to weathering. Traces of old river-beds have been found both north and south of the gneiss hill of Great Laufenburg. Mr. Walter agrees with Du Pasquier's conclusion that river deviations taking place on the morainic terraces before the last period of incision prevented the streams from finding their old beds.

ASIA.

Austrian Investigation in Southern Arabia.—Prof. David Müller communicated an account of Dr. Wilhelm Hein's expedition (see *Geographical Journal* for March, p. 370) to the meeting of the philosophical and historical section of the Vienna Academy of Sciences on April 23. Dr. Hein and his wife first made a stay of several weeks in Aden, in order to make photographic and ethnographic surveys and to study the Gibesti dialect; and in this they had the assistance of the British governor, as well as of the Austro-Hungarian consul. They left Aden, accompanied by two servants, on January 22, by the Government steamer *Mayo*, and reached Gishin on the 25th. Gishin (marked Kishin, or Keshin, on the maps) lies east of Aden, beyond Makalla, not far to the west of Ras Fartak, on the Hadramaut coast, in about lat. 15° 25′ N., long. 51° 30′ E. They remained here for sixty-six days, cut off during that time from all communication with the outside world. Their relations with the Sultan, to whom they brought letters of recommendation, were at first fairly good, perfect freedom of movement was allowed, and everything could be obtained for money and fair words; later, however, direct demands for money were made, and as these became more frequent and persistent, and were not acceded to, matters eventually became critical, and the travellers were only rescued by the steamer, which returned on Easter Sunday, and took them back to Aden. During the two months' stay at Gishin, Dr. Hein collected much valuable linguistic material, and made many photographs and sketches. He obtained about two hundred texts in the Mehri language, the dialect of Gishin, including legends and songs, and some Beduin songs. About one-third of these

were also written down in the Hadrami dialect, and the remainder edited with notes in Arabic. Of immediate geographical interest are the numerous itineraries which Dr. Hein was able to take down accurately, and his collection of statistics. Over the whole of Gishin, which is 3 to 4 leagues in length and 1 league broad, every house and tent has been set down, with the name of the owner, the number, sex, and approximate age of its inhabitants, and their possessions in cattle, fields, and date-palms—a statistical survey which is unique of its kind in Arabia. Frau Dr. Hein devoted herself more to the natural history of Gishin, and collected eighty species of fishes, and a hundred species of plants, besides lizards, snakes, beetles, etc., in each case with the local names. The attempt to obtain the bloom of the frankincense tree was at first unsuccessful, owing to the unfriendliness of the Sultan of Gishin, but Dr. Hein was fortunate enough to discover a small frankincense tree near the tanks at Aden, from which blossom and leaves, preserved in spirit, are now on their way to Vienna, and will be handed over to the Director of the Botanic Gardens.

The Mishmi Country.—We have already alluded, in noticing the annual report of the Survey of India for 1900, to the reconnaissance of a portion of the Mishmi country carried out during the military operations in that country in 1899–1900. We have since received the report on the Mishmi country drawn up by Lieut. G. L. S. Ward, who took part in the expedition as Field Intelligence Officer, accompanied by a large-scale map of the districts traversed, which lay north-east of Sadiya, to the east of the Dibang river during its course through the hills. Lieut. Ward gives an interesting sketch of the geography and ethnology of the region, and the appended sketches, by Captain Stevens, help towards a realization of its physical character. The hills range up to an altitude of 15,000 feet, and are greatly cut up by watercourses, which run between precipitous banks hundreds of feet below the plateau. The slopes are covered with dense tree-jungle, and the ill-defined paths run up and down at steep gradients, making them extremely dangerous in places. The country traversed is drained by the Ithun, a large river which joins the Dibang from the east. It is deep and swift, with many rapids, and is quite unnavigable. The Midu Mishmis (Chulikatta of the Assamese) occupy both banks of the Dibang, some of the more important villages being situated north of the junction of the Ithun, towards Tibet. East of them, the Mithun (Assamese *Bebejiya*, "outcast") Mishmis occupy the basin of the Ithun, while further east, in succession, are the Digaru, or Taiu, and Meju Mishmis, the latter in the direction of the Dzayul valley. There appear to be only two seasons, the cold weather and the rains, and during part, at least, of the cold weather, much snow falls on the hills. In the rains the whole country is saturated with moisture, which on fine days evaporates in a steamy moisture. The usual jhum system of cultivation is practised, Indian corn, millet, tobacco, opium, etc., being grown. From the Bebejiya country, wax, "Mishmi" or wormwood, and musk are the principal exports, while the Chulikattas export rubber only. Each of the four main divisions of the Mishmis is divided into clans, within which marriage is interdicted. The Chulikattas and Bebejiyas also do not intermarry. The Chulikattas are now somewhat civilized, and the Bebejiyas, though they have been described as ferocious cannibals, seem to be arrant cowards, and the accusation of cannibalism is untrue. The houses vary in length from 40 to 200 feet, and are divided into compartments. There are no houses for bachelors, or for the discussion of public affairs, as among the Abors. The two eastern sections of the tribe have no system of village defence, but palisades were seen among the western sections. Each village, even each house, is quite independent, no settled form of government existing.

The Flora of Tibet.—In a recent number of *Journal of the Linnæan Society*, Mr. W. Botting Helmsley gives a general sketch of the flora of Tibet, as known from the collections brought home by travellers and now in the herbarium at Kew. The paper, in the preparation of which Mr. Hemsley has had the assistance of Mr. H. H. W. Pearson, opens with a history of botanical discovery in Tibet, dealing subsequently with the climate of that region as affecting the vegetation, and sketching the itineraries of the various travellers, with notes on the plants collected at various parts of the route. The systematic list of the plants collected is followed by an account of the general characteristics of the Tibetan flora, as regards form and mode of growth, colour, altitudinal limits, etc. A very large proportion of the species are perennial herbaceous plants, with long thick tap-roots, and almost no stem, which may be either unbranched, bearing a single or compound inflorescence, or very shortly branched, with several inflorescences. When unbranched there is generally a rosette of leaves often lying flat on the ground, and when the stems are branched the leaves are usually very small and numerous. Plants of this description are generally very thinly scattered. Of Gramineæ and allied forms only forty species are at present known, but more probably exist, as abundant pasturages must occur, though in parts grass grows in tufts only. The woody element is exceedingly small, including nothing more than a foot above ground, while fleshy and large-leaved plants, aquatics, and bulbous plants and annuals are also rare. Diminutive plants, some not more than an inch high, with a terminal flower, are, on the contrary, a special feature. As regards the colour of the flowers, there is as much variety and brilliancy in individual blooms as in the British flora, but nothing to equal the intensity of colour characteristic of the alpine flora of Europe. Seeds seem to be ripened freely, and considerable facilities exist for their dispersal; the probabilities of successful germination are, however, small. The conditions are also unfavourable for the spread of plants vegetatively, and the increase in vegetation in Tibet, if any, must be exceedingly slow. On the other hand, there seems no positive evidence that it was ever more general than at present. Mr. Helmsley has entered into the question of the altitudinal distribution with much care, and he finds that some 130 species, or nearly half the total number found in Tibet, have been collected at 16,000 feet and upwards, six of these coming from 18,000 and over. This seems to show that there is no altitudinal limit to flowering plants except perpetual snow. A detailed analysis is made of the flora as regards the orders, genera, and species represented, together with a study of the affinities of the Tibetan flora to those of other regions. This brings out the fact that the bulk of the Tibetan plants have a wide range, 18·7 per cent. occurring in five or more other floral regions, from Persia and the Mediterranean to the Arctic. Forty-seven plants are common to the last-named region and Tibet, but, as might be expected, it is the Himalayan element which is best represented, 217 species, or 76·6 per cent. of the whole, occurring both in Tibet and the Himalayas, while 25·8 per cent. are apparently restricted to these two regions. The general conclusion is that the Tibetan flora is a derived one (derived since the Tertiary period), and it is from the Western Himalaya that the greater migration seems to have proceeded, possibly aided by the prevailing westerly winds.

The Riukiu (Luchu) and Bonin Islands.—The structural features of the island groups south of Japan are discussed in recent papers by Mr. S. Yoshiwara. The first deals with "Raised Coral Reefs in the Islands of the Riukiu Curve" (*Journ. Coll. of Science, Imp. Univ., Tokyo*, 1901, xvi. 1), which forms an arc between Kyūshū and Formosa. They are composed chiefly of Palæozoic rocks—limestones and quartzites found in the west, and clay, slate, sandstone, and pyroxenite or amphibolite on the east. Both dip regularly to the west, and strike parallel to the island

axis. These rocks are also found in Formosa. Pre-Tertiary volcanic rocks have been erupted through these. The outer sedimentary zone is of Tertiary rocks. The volcanic fissure is on the inner side of the sedimentary zone, and is continued southwards through the Pescadores. Since the rocks were folded, coral reefs have been built and raised, and are at present irregularly distributed. Hence these islands are homologous with the Lesser Antilles and the Banda islands. The Bonin islands, with which the second paper deals, have generally been regarded as a continuation of the Fuji volcanic chain, but Mr. Yoshiwara shows, in the May number of the *Geological Magazine*, that they really form part of an older and parallel volcanic chain of eocene age, covered with thick horizontal Miocene limestone, and lying a little to the east of the continuation of the younger Fuji volcanic line which passes through the Lot's Wife rock. There are no hot springs or earthquakes in the Bonin chain, but both are common in the Fuji chain, in which eruptions still take place. The Bonin or Ogasawara chain shows that there existed an old line of crustal weakness parallel to the Fuji line before the Japanese islands were formed.

New Journey of Messrs. Sarasin in Celebes.—*Globus* (vol. 82, No. 2) publishes a short note on the latest journey undertaken by Drs. Paul and Fritz Sarasin, the well-known explorers of Celebes. Writing from Macassar on May 10 last, the travellers announce their return, with valuable scientific results, from a journey in the chieftainship of Boni. A visit was first paid to Mount Bowonglangi, about 6500 feet high, on the borders of Boni and Gova. It is steep, and its ascent was toilsome though not dangerous. It is composed of eruptive rocks, which form precipices, but no signs of a crater were seen. A search was then made for a tribe of primitive natives, about whom vague rumours had been heard under the name To Ala (Ala = forest). They were said to dwell in the district of Lamontyong, which was therefore visited; and although difficulties were raised by the Raja, members of the tribe were at last brought in and were inspected by the travellers, who came to the conclusion that they belonged to a more primitive tribe than any yet known on the island. They dwell in caves (of which there are many in the district), plant some maize, are monogamous and truthful, and use no numerals above one. The specimens seen were said to be not so completely wild as some of their kindred, who keep strangers at a distance by throwing stones. The travellers hope, it is said, to make their way from Palopo, on the Gulf of Boni, to the Bay of Palos, in the west, thus crossing Central Celebes from south to north.

AFRICA.

The Du Bourg Expedition in Southern Abyssinia.—An account of this expedition, to which reference has been made more than once in the *Journal*, appears in the June number of *La Géographie*. The leader was supported by several assistants, each of whom undertook a special branch of scientific work, so that the expedition has resulted in additions to our knowledge, not only of the topography, but of the botany, zoology, etc., of the districts traversed. On certain parts of the route M. Du Bourg had been preceded by the Erlanger expedition as well as by Dr. Donaldson Smith and others. The divergences, however, were sufficient to allow of the mapping of a considerable amount of new country. The most important work, from a geographical point of view, was the examination of the country about the headwaters of the Jub and Webi Shebeli and the line of partition between them. The course of the Webi Shebeli itself was also followed for a considerable distance between 7° 15′ and 6° 15′ N., and laid down with greater precision than had previously been done, while the configuration of the country on the left bank within this section was studied. West of the river, a mountainous tract extending towards Giner (Ginea of Donaldson Smith), and separating the

Webi Shebeli from the Web (Jub basin), was examined, as well as the course of the Web itself. South of the Web there is a mountain *massif* with a mean altitude of 11,000 feet, which sends spurs to the east and south, giving rise to many streams flowing to the Upper Jub. Some of these were brought to light for the first time during an advance south to 5½°, which led across the Welmal and other tributaries of the Ganale, reached from the opposite direction by Bòttego. From the pass of Shedom, at the southern edge of the mountainous zone, the view ranges southward over an undulating plateau watered by these streams and falling gently to the Upper Jub. Unlike the treeless grassy plains of the Arussi country, this plateau supports a magnificent vegetation. It is very fertile, and would be adapted for every kind of cultivation. The Gallas formerly burnt clearings in the forest in order to obtain pasturage for their herds, but they have been driven north by famine, and the country is now uninhabited. On the northward route to Adis Ababa the Wabi, or headstream of the Webi Shebeli, was crossed at a point nearer its source than had been reached either by Donaldson Smith or Erlanger. In the map which accompanies the paper the source is placed as far west as 39°. Where crossed it was still an important stream, and its wide valley was inhabited by Galla. The plain of Badda to the north seems to be drained towards Lake Zwai. From the Web a section of the expedition took a more easterly route *viâ* Sheikh Husein, which led, beyond the Wabi, across the almost uninhabited region of Boke. M. Du Bourg sketches the results of the expedition from a geological, botanical, zoological, and medical point of view. As regards geology, considerable interest attaches to the sedimentary strata, which here, as in so many parts of Central Africa, are exactly horizontal. They are found in many isolated positions, but always at the same altitude, the upper limit being 7200 feet.

Wellby's Ruzi.—In commenting, in a recent number of *Globus* (vol. 82, No. 2), on Major Austin's paper published in the June number of the *Journal*, Herr Brix Forster recurs to his contention (cf. *Journal*, vol. xviii. p. 310) that the Ruzi of Wellby is not the Akobo but the Upper Pibor. He makes the surprising statement that Major Austin has now corrected his former view, having thus apparently not read the latter's communication in the March number of the *Journal* (p. 385), in which the English traveller showed in a convincing way the accuracy of his original contention. Some confusion is possibly caused by the fact that Wellby found two streams bearing the native name "Ruzi," but in the letter alluded to Major Austin made it plain, if doubt had existed before, that the river identified by him with the Akobo was that called by Wellby the first Ruzi (by far the more important of the two), as he imagined that it was the same stream as had been found by him flowing from about 4° N. It is only necessary to lay down Wellby's route on any of the recent maps of the Sobat system, reading at the same time the account given of the march down the valley of the Eastern Ruzi from 6° 40′ to 7° 40′ N. in 'Twixt Sirdar and Menelik,' to be convinced that Wellby in this part of his route was following the Akobo, first discovered by Bòttego on his last fatal journey. On the assumption that the Eastern Ruzi is the Pibor, it would be necessary to suppose Wellby's longitudes to be roughly a degree in error; while by introducing the minor correction suggested by Major Austin as regards the lower course of the Ruzi (where not seen by Wellby), the latter's delineation of this river is brought into full agreement with the latest mapping of the Akobo.

Dr. Dantz's Geological Researches in German East Africa.—We have already referred briefly to some of the results of the journeys in East Africa carried out since 1898 by Dr. Dantz for the purpose of geological investigations. During the course of these journeys few important parts of the German East

African territory were left unvisited, the routes extending from the coast to the Victoria Nyanza, Lakes Tanganyika, Rukwa, and Nyasa, besides traversing the intervening districts, together with the greater part of the Rufiji basin, in various directions. The first instalment of a paper, in which both the course of the several journeys and their general and geological results are given, appears in No. 2 of the *Mitteilungen aus den Deutschen Schutzgebieten* for the current year. The geological formations found along the various routes are described with much minuteness, and cannot be discussed here, though the facts thus brought together will form a valuable basis for a knowledge of the structure of the country. A few more general questions are, however, touched upon, and an important discovery was that of a large number of Jurassic fossils at three places in Usaramo, on which a report is inserted by Dr. Hans Menzel. Of interest, too, are Dr. Dantz's remarks on the geological history of the extensive steppes of the gneiss region of the interior. As is well known, they reach a very considerable elevation—little inferior to that of their outer ramparts ("Randbergen"), while from their general surface isolated peaks and ridges ("Inselberge") rise. Both the bounding ranges and the isolated elevations are formed of massive gneiss, while the soil of the steppes is composed of the products of the disintegration of the gneiss, seldom more than 35 feet deep, and is again underlaid by massive gneiss, which has the same structural lines as in the mountains where it reaches the surface. These features are explained as the result of the dislocations to which the archæan rock-masses have been subject, coupled with subsequent chemical and mechanical denudation which has tended to fill the depressions resulting from such dislocations. In the great central gneiss plateau, marked by extreme uniformity, of which Tabora may be taken as the middle point, Dr. Dantz distinguishes two distinct zones—an outer with marked planes of foliation, with a general strike from west-north-west to east-south-east, and a central with rocks either gneissose or granitic in character, in which the most common direction is from north-north-west to south-south-east. Another conclusion of general interest at which Dr. Dantz arrives is that the formation of the Central African rift-valley, in which Tanganyika now lies, was not the work of a single geological epoch, but involved the lapse of long ages. This results from a consideration of the relations of the three formations—gneiss, red sandstone, and diabase—which occur east of the central part of the lake. A useful map embracing the whole of German East Africa, and showing all Dr. Dantz's routes on the scale of 1 : 2,000,000, accompanies the paper.

The Frontiers of the Kamerun.—It is announced that the Commission for fixing the boundary between the Kamerun and French Congo to the east of the former has finished its work, and that the station of Ngoko, north-west of Wesso, which was found to lie within French territory, has been evacuated by the Germans. A map of the southern frontier, as surveyed by Stabsarzt Hoesemann, of the Boundary Commission, is given in the *Deutsches Kolonialblatt* for July 1, with the first instalment of a narrative of the expedition. It completes and corrects the work of Crampel, Fourneau, Lesieur, and Von Stein in this region, and shows once for all that the Ja has no connection with the system of the Ogowe, such as was supposed by Lesieur.

The French in the Lake Chad Region.—An important scientific expedition is being despatched by the French Colonial Office, with the concurrence of other bodies, to the region of the Shari and Lake Chad, under the command of Prof. A. Chevalier, who will be assisted by a competent staff. The objects of the expedition are not political, but it is proposed to study in detail the natural resources of the country, in order to arrive at trustworthy conclusions as to the prospects of commercial development. The expedition will probably be at work at least two

years. Meanwhile, it seems to be the intention of the French authorities to pay attention rather to the development of territory already under control, than to seek further extension. By a decree dated July 5 last, the administration of the Congo-Shari territories has been reorganized. The whole of the area up to Lake Chad is placed under one commissioner-general, the separate government of the "Pays et Protectorats du Tchad," which has hitherto formed one of the "Territoires Militaires" of the Sudan, being abolished. The immediate administration of this region may, however, be placed in the hands of a subordinate official responsible to the commissioner-general. It seems to be generally understood that any forward movement in Wadai and Kanem will, under the new *régime*, be for the present, at least, abandoned, while in the Shari basin French action will be limited to a general political supervision.

AMERICA.

Brown-Harvard Expedition to the East Coast of Labrador.—The east coast of Labrador offers unique opportunities for exploration to those who can spare only the months of the long vacation. In 1900 Dr. Delabarre, Professor of Psychology in Brown University, and Dr. Daly, then Instructor in Geology in Harvard University, but now on the staff of the Canadian Geological Survey, with four Harvard undergraduates, spent from July 13 to October 3 on a forty-ton schooner, with which they sailed to Nachvak bay and back. Plants, birds, rocks, and currents were specially studied, and regular meteorological observations were made. Dr. Delabarre has given an account of the expedition in the *Bulletin of the Geographical Society of Philadelphia* (April, 1902), and Dr. Daly has described the 'Geology of the North-East Coast of Labrador" in the *Bulletin of the Museum of Comparative Zoology at Harvard* (vol. xxxviii., February, 1902). The lack of continuous vegetation on the Labrador coast makes geological observations especially easy. The coast lies almost along the axis of a denuded pre-Cambrian mountain range—"a great wilderness of innumerable rounded, ice-worn hummocks, generally gneissic in composition." There is a decided correspondence in altitude of the bedded rocks throughout, and their edges are directed approximately north-east to south-west. This Labrador trend meets the Appalachian trend at right angles in Belleisle, and probably in Newfoundland. Dr. Daly suggests that the margins of the Newfoundland banks are an expression of this intersection. In the belt of 150 miles from Hebron to Cape Chidley the heights are greater, rising to over 5000 feet. These mountains, which Dr. Daly calls the "Torngat Range," differ orographically though not structurally from those to the south, and are "lofty, rugged, and oftentimes serrate," and these higher parts have not been glaciated. The coast is incised by true fiords with irregular floors and "hanging" valleys. The Nachvak fiord was specially mapped both above and below water. The glacial action towards the end of the Glacial epoch did not extend above 2100 feet. Among the glacial markings observed were the "lunoid furrows," not yet fully explained. There are many raised beaches, the highest varying from 250 to 575 feet high, and giving evidence of differential movements in the land since they were formed. Dr. Daly follows De Geer in concluding that uplift has been greatest where the ice formerly was thickest, and that the crust is sufficiently elastic to respond to the removal of the load of a regional glacier. Both the Newfoundland and Labrador coasts are still rising.

POLAR REGIONS.

The Spitsbergen Degree Measurement.—An expedition is being again sent out from Sweden during the present summer to complete the operations for the measurement of an arc of the meridian, which it was impossible to finish last

year owing to the unfavourable meteorological conditions. The date fixed for its departure was July 26, when the party was to embark in the *Laura* under the leadership of Dr. Rubin, assisted by Dr. von Zipel as astronomer, and Lieut. Dunér as topographer. Supplies for a year are taken, but it is hoped that the triangulation in the northern part of the Spitsbergen group may be completed by the autumn. An account of the work of the Russian expedition, which, as is known, completed its share of the operations last year, and undertook also important topographical surveys and research into glacial phenomena, has lately been presented by Prof. Chernicheff to the St. Petersburg Academy of Sciences.

MATHEMATICAL AND PHYSICAL GEOGRAPHY.

Zoo-Geographical Discoveries in the Red Sea.—It is the opinion of most zoologists that the character of a typical deep-sea fauna is determined by the low temperatures occurring in the abysmal depths of the oceans. The dredgings of the *Pola* (Austro-Hungarian Expedition, see *Geographical Journal*, August, 1896, p. 180; January, 1898, p. 75; and December, 1898, p. 571) have, however, led to a result contrary to this view. In the *Sitzungsberichte der Kaiserl. Akademie der Wissenschaften in Wien* (Math. naturw. Klasse. Bd. cx., Abth. i.) Prof. Theodor Fuchs, Director of the palæontological section of the Natural History Museum in Vienna, states the following conclusions, based on a study of the unpublished work of the zoologists of the expedition, Hofrath Steindachner, Drs. von Marenzeller, Penther, and Sturany. The assumption is based on the conditions found in the open ocean, where, in the tropics, the fall of temperature with increase of depth takes place so rapidly that the change in the fauna appears to coincide with it. But in certain parts of the Pacific, especially in the regions round New Guinea, the Solomon islands, the New Hebrides, the Fijis, and Samoa, the temperature at 180 metres (100 fathoms) is 18° to 21° C. (64° to 70° F.), and a characteristic fauna is found which, in its siliceous sponges, deep-sea corals, stalked crinoids, etc., closely corresponds to the fauna occurring at a depth of 1100 metres (600 fathoms), in a temperature of 5° C. (41° F.), off the Kermadec islands, north of New Zealand. Further, temperatures of 12° to 13° C. (53° to 55° F.) are found at the greatest depths in the Mediterranean, and a typical fauna occurs there at a depth of 200 metres. These examples of high temperature in the depths are far exceeded in the Red Sea, where the temperature of 23° C. (73° F.), corresponding to the limits of the coral reefs, extends down to 300 metres (160 fatnoms), and even in the greatest depths (2190 metres, or 1200 fathoms, in lat. 20° N., south-south-west of Jiddah) the temperature does not fall below 21° C. (70° F.). The *Pola* Expedition is the first to obtain information about the fauna of such a region. The typical organisms of a deep-sea fauna are the siliceous sponges, of which specimens were first found off the island of Cebu in the Philippines, where the natives, using their own tackle, take them in large quantities from depths of 200 metres. The *Challenger* obtained them in 150 metres (80 fathoms), near the same place, and the dredge brought up a specimen from 130 metres (70 fathoms) near Kerguelen; but they have never been found in shallower water or on the littoral, although abundant in the deep waters of all seas from pole to pole. In the Red Sea siliceous sponges were brought up by the dredge from 690 metres (380 fathoms), an indication at once of the nature of the fauna. The frequent occurrence of Neæra was also remarkable, just as in the open ocean, where it is rarely absent; in the *Challenger* dredgings Neæra was often the only Lamellibranch. Other widely distributed and characteristic forms, such as Amussia, Verticordia, etc., were also obtained in the warm depths of the Red Sea; a true deep-sea fauna being, in effect, met with at a depth of 200 metres, in temperatures of 23° to 34° C. (73° to 75° F.), and

down to 900 metres (490 fathoms). Few deep-sea fishes were obtained; Steindachner enumerates only five species between 340 and 1150 metres (190 to 630 fathoms), but it is remarkable that amongst them, and amongst the deep-sea crabs, were many found in the Mediterranean, notwithstanding the great difference in the temperature conditions in the two seas. The general conclusion to be drawn is that the fauna inhabiting the Red Sea at depths below 100 fathoms, although it has certain minor peculiarities, is a typical deep-sea fauna, in spite of prevailing temperatures of 21° to 24° C. (70° to 75° F.).

The Migration of Birds.—With reference to the note on this subject in the last number of the *Journal* (p. 108), and Dr. Floericke's statement, there quoted, that "Mountain ranges stretching across the line of flight are avoided (by birds) even at the cost of a considerable circuit," a correspondent writes: "This may be true as a rule, but it has large exceptions. Three or four separate exploring parties have found the surface of the upper portion of the Bezingi glacier and other Caucasian glaciers strewn with the corpses of migratory birds, which had evidently perished from storm and cold (see Merzbacher's 'Kaukasus,' vol. i. p. 745). The Bezingi glacier lies under the loftiest portion of the Caucasian watershed." It may also be mentioned that though Dr. Floericke speaks of the three southern peninsulas as supplying the natural bird-highways between Europe and Africa, he shows on his map other routes following the east and west coasts of Corsica and Sardinia.

Experimental Botanical Geography.—Under this title Prof. Bonnier of Paris describes his latest researches on the subject of plant physiology and distribution (*Annales de Géographie*, May, 1902). Seven or eight years ago he showed that plants transported from the plains to 6000–8000 feet soon acquire the structure and function of alpine species. His new experiments are of two kinds. In the first he took selected herbaceous plants (such as the common primrose, columbine, strawberry, dog-violet, stinking hellebore, *Carex cæspitosa*, etc.) from beds in the Garden of Experimental Botany at Fontainebleau, and a number of cuttings from common trees and shrubs (such as beech, lime, fuschia, lilac, gooseberry, etc.), and planted them in a garden near Toulon, planting at the same time, in the case of the cuttings, some of them at Fontainebleau. To counteract any differences in soil, some of the herbs, shrubs, and trees were grown at Fontainebleau on soil transported from the Toulon garden. Notable differences were observed from the first year in the form and functioning of nearly every species. At Toulon the plants developed a woodier stem, broader, thicker, more coriaceous and less indented leaves, with more marked nerves, often persisting longer on the stem, from which the branches diverged at a wide angle. These are normal characteristics of Mediterranean plants, which pass through two resting periods in the year—during the drought of summer and during the cold of winter—and in the case of the persistent plants cultivated at Toulon, it was found that two zones of vessels were formed, one in spring and one in autumn, separated by a zone of wood almost free from vessels. The walls of the peripheral cells were thickened in the south, the stomata were more sunken, and hairs often became more abundant. That is to say, that a great number of plants of the temperate zone change their form and structure in adapting themselves to the Mediterranean climate. Once more we have an illustration of the now generally accepted fact that climate is the prime factor in plant distribution. Prof. Bonnier has made even more ingenious experiments. Bringing plants, such as *Saxifraga oppositifolia*, *Silene acaulis*, and *Salix reticulata*, from the alpine zone of the Pyrenees in spring, he subjected them, in the underground chambers beneath the central market of Paris, to constant light and moist cool temperatures such as characterize Spitsbergen in summer.

The form and structure were again modified, and became of Spitsbergen instead of Pyrenean type. Another set of experiments consisted in taking plants growing round Paris, and at the Fontainebleau botanical station putting them out all the summer day in normal conditions, but at night setting them in a room near the freezing point. In the first season, but much more markedly at the end of the second year, after being covered all winter with snow, they possessed almost all the external characters, internal structure, and physiological functions of alpine plants. This shows that the chief characteristics of alpine species are directly due to the plants having to live in diurnal alternations, not merely of light but of extremes of temperature. These laboratory experiments are even more striking than the garden ones previously recorded, and in addition to their bearing on the question of plant geography, they have an almost greater interest in connection with investigations into the part played by the environment in the evolution of organisms. It may, however, be remarked that, according to the view of Prof. De Vries, whose experiments in the production of new forms of *Œnothera* have lately been described in *Science*, changes in environment cause adaptation only, not variation, the former standing in no relation to heredity or the origin of species, while the latter is quite independent of environment.

New Geographical Serial.—The recent addition to the existing geographical serials in the German language, which has been made in the form of a new magazine published by the firm of Hölzel, of Vienna, under the editorship of Prof. Franz Heiderich, promises to be of value, both as regards its method and objects. The *Vierteljahrshefte für den Geographischen Unterricht*, of which the fourth part was issued in July, have, under the judicious management of their editor, already aroused an interest in geographical circles, and may be said to have already established an assured position. The new periodical takes an intermediate place between those publications on the one hand which are mainly devoted to the dissemination and discussion of the results of geographical research, and on the other those whose chief aim is educational, such as the *Zeitschrift für Schulgeographie*, also published in Vienna. Its promoters consider with justice that a gap exists between the geography at present studied in the higher educational establishments and that which is taken up as a necessary part of the ordinary school curriculum. The numbers of the new magazine which have so far appeared show the efforts which it is making to bridge over this gap, on the one hand by articles which aim at giving a more scientific character to the school teaching, on the other by a discussion of the wants felt by those engaged in higher education as a result of the defects in the middle and lower schools. Its contents include papers on scientific geography and methodology, descriptions of typical geographical features, a summary of the results of current research, and, last but not least, detailed and critical reviews of geographical literature, both books and maps.

CORRESPONDENCE.

Mr. Freshfield's Paper on the Glaciers of Kangchenjunga.

I HAVE read with much pleasure the extremely interesting paper by Mr. Freshfield on the glaciers of Kangchenjunga, which appeared in the April number of the *Journal*. Messrs. Freshfield and Garwood have supplied a valuable addition to our geographical knowledge of that glacier region, a point which is a weak one in our Indian Survey maps. As the shortcomings of these are necessarily somewhat prominently brought forward, it will perhaps be of interest if I explain the conditions under which such maps have been constructed, and the views of the

Government of India, as represented by the Survey of India, on the surveys and mapping of such outlying portions of the Indian Empire and contiguous countries.

As soon as any country comes under the direct rule or influence of the Government of India it has always been deemed a first essential to provide as quickly as possible, for administrative and military purposes, a map of it. In such cases survey-parties are at once sent forward to carry out a reconnaissance survey of the country in question. These are usually executed on a scale of 4 miles = 1 inch, and are always based on triangulation. As they are pushed forward with the utmost speed compatible with sufficient accuracy for the purpose required, it follows that, in the more inaccessible portions of the country, which have little value either from the military or administrative point of view, it would be a waste of time and money to make an elaborately accurate survey of minor details. In subsequent years, should the country become more important from any point of view, larger-scale maps, usually on the 1-inch scale, are constructed. Even in these latter, however, minute accuracy of detail in the more inaccessible portion of the mountainous regions would not be insisted on, as the cost of such surveys would be out of all proportion to their value to the Government.

In illustration of the above, I may cite the surveys of the North-West Himalayas, which were undertaken between 1850 and 1862, soon after we obtained free access to the country. During those years a reconnaissance survey of that region, reaching from Nepal on the east up to and including Kashmir on the west, was carried out. This survey was based on a very complete and far-reaching system of triangulation, all prominent peaks coming within view of the triangulators being fixed. The topography was surveyed with the plane-table, mainly on the scale of 4 miles = 1 inch, though parts of Kashmir were mapped on the ½-inch scale.

The survey was on the whole wonderfully accurate, if one considers the speed at which it was carried out. Each survey-party brought back annually completed surveys of from 10,000 to 13,000 square miles, the average out-turn of each individual surveyor being from 2000 to 2500 square miles. It will be seen from these figures that any attempt at surveying the full detail of glaciers and of the higher mountains was out of the question; the marvel is how even such accomplished surveyors as Colonel Godwin Austen and those associated with him were able to get so great an amount of accurate detail in so short a time.

In later years—about 1870—it was found that this reconnaissance survey was on too small a scale for the proper administration of the British districts of Kumaon and Garhwal, and a complete topographical map of those districts on the scale of 1 inch = 1 mile was made. Similarly, lately, the hill-districts of Kulu and Kangra have been surveyed for administrative purposes on a large scale. The remaining portions of the older reconnaissance being in native territory have up to the present sufficed for the needs of Government.

On the east of the Himalayas, in Sikkim, this preliminary reconnaissance survey was also carried out, though at a much later date. The country was not so thoroughly surveyed as the more western regions, the work partaking more of the nature of a reconnaissance, many of the outlying valleys being only sketched from a distance.

It will be seen from the above that no attempt has been made in the surveys of the Himalayas to delineate in close detail the peaks and glaciers of the higher mountains, and it seems unlikely that such work will be taken in hand by the Survey Department. We must therefore look to enterprising travellers and skilled mountaineers, such as Messrs. Freshfield and Garwood, who possess the necessary ability and determination, to map out the more intricate detail of rock and glacier.

The Survey of India will only too gladly accept such additions to their knowledge whenever it is evident that the work is up to the required standard of accuracy. It should be recollected, however, that the criterion of goodness is not the beauty of the finished map, but the method employed in the survey and the skill with which it has been accomplished.

There is one point in Mr. Freshfield's paper about which I would like to say a word—I refer to the note at the foot of p. 460, which runs as follows: "Sir T. Holdich has informed me that the cartographers were authorized to supply conventional detail where no authentic detail was forthcoming." I cannot help thinking that there must be some misunderstanding about this. After a service of thirty years in the Indian Survey Department, and having been employed for the greater part of that time on Himalayan and frontier surveys and mapping, I can only say that I have never heard of any such authorization. So far from this being the case, it has always been laid down that, while officers employed on reconnaissance surveys are to attempt to fix and sketch all detail which they see, however distant it may be (as it may possibly never be seen again), they are invariably to show, by the method and style of their drawing, the difference between work actually surveyed in detail and that sketched from a distance. In fact, the late General Walker, in one series of frontier maps, combined both the horizontal and vertical systems of hill-shading, the former to show ground actually surveyed, and the latter that which was merely sketched. In no case, however, has it been permitted to fill in conventional detail when no such detail has been seen. Such a proceeding would absolutely spoil the value of any map.

As the surveys are invariably executed by plane-table, they are brought in in a finished state, and the cartographers, *i.e.* those who draw the fair maps for publication, have nothing to do but to redraw the plane-table sheets in a method suited for our system of publication by photozincography, and are strictly forbidden to add or alter anything in the originals.

It, of course, does not follow that all detail shown on an Indian Survey map is strictly accurate. The best of surveyors are occasionally deceived by the apparent lie of mountain ranges and streams when sketched from a distance, and occasionally it may happen that surveyors, set to work in the more inaccessible regions where their maps cannot readily be checked, either through laziness or inability, bring in work shown as accurately surveyed which, on subsequent examination in after years, turns out to be anything but correct. Such cases are, however, I am glad to say, of rare occurrence.

ST. GEORGE GORE,
Colonel R.E.
Surveyor-General of India.

June 16, 1902.

GEOGRAPHICAL LITERATURE OF THE MONTH.

Additions to the Library.

By EDWARD HEAWOOD, M.A., *Librarian*, R.G.S.

The following abbreviations of nouns and the adjectives derived from them are employed to indicate the source of articles from other publications. Geographical names are in each case written in full:—

A. = Academy, Academie, Akademie.
Abh. = Abhandlungen.
Ann. = Annals, Annales, Annalen.
B. = Bulletin, Bollettino, Boletim.
Com. = Commerce.
C. Rd. = Comptes Rendus.
Erdk. = Erdkunde.
G. = Geography, Geographie, Geografia.
Ges. = Gesellschaft.
I. = Institute, Institution.
Is. = Izvestiya.
J. = Journal.
k. u. k. = kaiserlich und königlich.
M. = Mitteilungen.
Mag. = Magazine.
Mem. = Memoirs, Mémoires.
Met. = Meteorological.
P. = Proceedings.
R. = Royal.
Rev. = Review, Revue.
S. = Society, Société, Selskab.
Sitzb. = Sitzungsbericht.
T. = Transactions.
V. = Verein.
Verh. = Verhandlungen.
W. = Wissenschaft, and compounds.
Z. = Zeitschrift.
Zap. = Zapiski.

On account of the ambiguity of the words *octavo*, *quarto*, etc., the size of books in the list below is denoted by the length and breadth of the cover in inches to the nearest half-inch. The size of the *Journal* is 10 × 6½.

A selection of the works in this list will be noticed elsewhere in the "Journal."

EUROPE.

Alps. **Whymper.**

The Valley of Zermatt and the Matterhorn. A guide by Edward Whymper. 6th edition. London: John Murray, 1902. Size 7½ × 5, pp. xiv. and 224. *Maps, Plans, and Illustrations. Price 3s. net. 2 Copies, one Presented by the Author, the other by the Publisher.*

Alps—Mont Blanc. **Whymper.**

A Guide to Chamonix and the Range of Mont Blanc. By Edward Whymper. 7th edition. London: John Murray, 1902. Size 7½ × 5, pp. xiv. and 206. *Maps and Illustrations. Price 3s. net. 2 Copies, one presented by the Author, the other by the Publisher.*

Ardennes. *Naturw. Wochenschrift* **1** (1902): 233–236. **Wagner.**

Die Ardennen. Eine geologisch-geographische Skizze. Von Dr. Phil. P. Wagner. *With Map.*

Austria—Bohemia. *Deutsch. Rundschau G.* **24** (1902): 359–362. **Wagner.**

Aus dem Mittelgebirge Deutschböhmens. Von Eduard Wagner. *With Illustrations.*

Balkan Peninsula. *Z. Ges. Erdk. Berlin* (1902): 196–214. **Cvijić.**

Forschungsreisen auf der Balkan-Halbinsel. Von Prof. Dr. J. Cvijić.

Balkan Peninsula—Railway. *Globus* **81** (1902): 341–346. **Meinhard.**

Die Balkanbahnen in ihren Beziehungen zur Bagdadbahn. Von Friedrich Meinhard. *With Map.*

Belgium—Haine. **Cornet.**

Quelques remarques sur le bassin de la Haine. Par J. Cornet. (Extrait des Annales de la Société géologique de Belgique, t. xxvii., Bulletin.) Liége, 1900. Size 9½ × 6½, pp. 8. *Presented by the Author.*

Central Europe. *G. Tidskrift* **16** (1901–1902): 173–183. **Vahl.**

De kvartære Stepper i Mellemevropa. Ved M. Vahl.

On the steppe-period which came between and after the glacial periods in Central Europe.

France. *B.S.G. Com. Bordeaux* **28** (1902): 125–135, 159–166. **Saint-Jours.**

Les fleuves côtiers de Gascogne. Par Capitaine Saint-Jours. *With Illustrations.*

France—Brittany. *B.S. Bretonne G.* (1901): 192–201. **Layec.**

Renseignements statistiques sur la Bretagne. Par A. Layec.

France—Census. *Deutsch. Rundschau G.* **24** (1902): 274–276. ———

Die Ergebnisse der Volkszählung in Frankreich vom 24. März 1901. *With Map.*

France—Meteorology. *Ann. G.* **11** (1902): 111–116. **Passerat.**

Essai d'une carte de la répartition des jours de gelée en France. Par C. Passerat. *With Map.*

France—Pyrenees. *Annuaire Club Alpin Français* **27** (1900): 244–261. **Lacoste and Verdun.**

Exploration de la région des lacs du Pic du Midi (massif de Néouvielle). Par M. A. Lacoste et M. le Dr. P. Verdun. *With Illustration.*

Germany. *Jahresb. G. Ges. München* (1900–1901): 1–37. **Tein.**

Beziehungen zwischen Niederschlag und Abfluss im Maingebiete. Von Maximilian von Tein. *With Map and Diagrams.*

Abstract from the work on the Main region, published by the Baden 'Zentralbureau für Meteorologie und Hydrographie.'

Germany—Baden—Kaiserstuhl. *Ann. G.* **11** (1902): 144–152. **Demangeon.**

Contribution à la géographie du Kaiserstuhl en Brisgau. Par A. Demangeon. *With Map and Plates.*

The Kaiserstuhl is an ancient volcano between the Upper Rhine and the Black Forest.

Germany—Bavaria. *Jahresb. G. Ges. München* (1900–1901): 38–57. **Ebert.**

Seespiegelschwankungen im Starnberger See. Von Hermann Ebert. *With Diagrams.*

Germany—Bavaria. *Jahresb. G. Ges. München* (1900–1901): 76–98. **Gruber.**

Die 1896 bis 1900 zur Landeskunde Bayerns erschienene wichtigere Literatur. Von Dr. Christian Gruber.

Germany—Bavaria. *Jahresb. G. Ges. München* (1900–1901): 58–75. **Ule.**

Die Entstehung und die physikalischen Verhältnisse des Würmsees. Von Willi Ule.

A summary of the results of the author's examination of the Würmsee, which have already been published in a memoir (cf. *Journal*, vol. xix. p. 381).

Germany—Elbe. *Ann. G.* **11** (1902): 54–67, 134–143. **Auerbach.**

La régime de l'Elbe. Par B. Auerbach.

Based on the great official work issued in 1898, but written with full knowledge of other literature on the Elbe.

Germany—Meteorology. **Perlewitz.**

Versuch einer Darstellung der Isothermen des Deutschen Reichs für Jahr, Januar und Juli nebst Untersuchungen über Regionale thermische Anomalieen. Von Dr. Paul Perlewitz. (Forschungen zur deutschen Landes- und Volkskunde . . . herausgegeben von Dr. A. Kirchhoff. Vierzehnter Band, Heft 2.) Stuttgart: J. Engelhorn, 1902. Size 9½ × 6½, pp. 79–150. *Maps.*

Germany—Prussia. *Globus* **81** (1902): 277–279. **Wüst.**

Nachweis diluvialer Brackwasseransammlungen im Gebiete der heutigen Mansfelder Seen. Von Dr. Ewald Wüst.

Germany—Saxony. *M.V. Erdk. Leipzig* (1901): 89–149. **Bohn.**

Die Siedelungen in der Leipziger Tieflandsbucht nach Lage und Gestalt. Von Dr. Richard Bohn. *With Map.*

Five types of settlements are distinguished on the map.

Holland. *Popular Sci. Monthly* **60** (1902): 551–555. **Gore.**

The Draining of the Zuider Sea. By Prof. J. H. Gore.

Holland. *Tijds. K. Ned. Aard. Genoots. Amsterdam* **19** (1902): 296–327. **Lorié.**

De verhouding tusschen den Rijn en het landijs. Door Dr. J. Lorié. *With Map.*

On the influence of the ice of the glacial epoch on the former course of the Lower Rhine, as evidenced by old river-terraces.

Hungary—Carpathians. *Annuaire Club Alpin Français* **27** (1900): 262–299. **Vielliard.**

Dans les Karpates; les Hautes-Tatry. Par M. Edme Vielliard. *With Illustrations.*

Iceland. *La G., B.S.G. Paris* **5** (1902): 153–154. **Lapparent.**

La Carte géologique de l'Islande par M. Thoroddsen. Par A. de Lapparent.

Montenegro. *B.S.G. Italiana* **3** (1902): 129–148, 243–267. **Baldacci.**

Nel Montenegro Sud-Orientale, conferenza del socio dott. A. Baldacci. *With Illustrations.*

Montenegro. **Cora.**

Guido Cora. Nel Montenegro. Impressioni di Viaggio (1899). Roma, 1901. Size 10 × 6½, pp. 72. *Illustrations. Presented by the Author.*

A useful addition to the scanty literature on Montenegro.

Northern Europe. *Deutsche Rundschau G.* **24** (1902): 295–306. **Stavenhagen.**

Nordisches Kartenwesen. Von W. Stavenhagen.

On the present position of official cartography in Norway, Sweden, and Denmark.

North Sea.

North Sea Pilot. Part iv. The Eastern Shores of the North Sea, from Cape Gris Nez to the Skaw. Sixth edition. London: Eyre & Spottiswoode, 1901. Size 9½ × 6, pp. xxiv. and 286. *Price* 2*s.* 6*d. Chart. Presented by the Hydrographer, Admiralty.*

Norway—Finmark. **Karlsen and Storm.**

Norske G. Selsk. Aarbog **12** (1900–1901): 1–23, 177–178.

Finmarkens Beskrivelse af Erkebiskop Erik Walkendorf. Af dr. K. H. Karlsen og dr. Gustav Storm. *With Facsimile.*

Reproduction of the Latin text (with translation) of a manuscript description of Finmark contained in the Vatican archives, which seems to have been used by Olaus Magnus.

Russia—Finland—Language. *Ymer* **22** (1902): 15–18. **Wiklund.**

Finska språkets nuvarande utbredning i Värmland och Grue finnskog. Af K. B. Wiklund. *With Map.*

Russia—Glacial Action. **Arçtowski and Bertrand.**

Notice sur l'abrasion glaciaire. Par Henryk Arçtowski. Action des anciens glaciers sur le relief actuel de la Russie. Par J. Bertrand. (Extrait du Bulletin de la Société Belge de Géologie, etc. Tome xv., 1901, pp. 693–701. *Maps.*) Bruxelles, 1902. Size 9½ × 6½. *Presented by M. J. Bertrand.*

Scandinavia. *Ann. G.* **11** (1902): 117–133. **Högbom.**

Sur la tectonique et l'orographie de la Scandinavie. Par A. G. Högbom. *With Map.*

Spain. *Z. Ges. Erdk. Berlin* (1902): 165–168. **Ramann.**

Das Vorkommen Klimatischer Bodenzonen in Spanien. Von Prof. Dr. E. Ramann. *With Map.*

Spain—Majorca. *Annuaire Club Alpin Français* **27** (1900): 300–319. **Vuillier.**

Aux rivages de Majorque: souvenirs des pirates barbaresques. Par M. Gaston Vuillier. *With Illustrations.*

Straits of Gibraltar. *J.S. Arts* **50** (1902): 462–487. **Crease.**

Ceuta and Gibraltar. By Major-General John F. Crease. *With Maps.*

The writer advocates the exchange of Gibraltar for Ceuta, and makes remarks on the possibilities of development offered by Morocco.

Sweden. *B. Union G. Nord de la France* **23** (1902): 18–31. **Lefébure.**

Voyage en Suède. Par A. Lefébure. *With Illustrations.*

Switzerland. *Le Globe, B.S.G. Genève* **41** (1902): 24–31. **Krafft.**

Éboulement préhistorique de Flims. Par M. A. Krafft.

This old landslip, which blocked the course of the Vorder Rhein, has an area of 52 square kilometres.

Switzerland. **Messerschmitt.**

Internationale Erdmessung. Das Schweizerische Dreiecknetz herausgegeben von der Schweizerischen geodätischen Kommission. Neunter Band. Polhöhen und Azimutmessungen. Das Geoid der Schweiz. Im Auftrage ausgeführt und mit Ausnahme der Kapitel ix. und xxiv. bearbeitet von Dr. J. B. Messerschmitt. Zürich: Füsi & Beer (vorm. S. Höhr), 1901. Size 12 × 9, pp. viii. and 252. *Plates.*

Switzerland. **Streun.**

Die Nebelverhältnisse der Schweiz. Inaugural-Dissertation zur Erlangung der Doktorwürde der hohen philosophischen Fakultät der Universität Bern vorgelegt von Gottfr. Streun. (Sonder-Abdruck aus den Annalen der Schweizerischen meteorologischen Centralanstalt, Jahrgang, 1899.) Zürich, 1901. Size 11 × 9½, pp. 40. *Maps. Presented by the Author.*

Switzerland—Laufenburg. **Walter.**

Vierteljahrs. Naturforsch. Ges. Zürich **46** (1901): 232–263.

Ueber die Stromschnelle von Laufenburg. Von Heinrich Walter. *With Plan and Illustrations.*

Gives the results of a careful geological and topographical survey (cf. *ante*, p. 225).

Turkey. *Deutsche Rundschau G.* **24** (1902): 317–321. **Braun.**

Ein Ausflug zum Alem-Dagh. Von Fritz Braun.

United Kingdom. *Rep. Brit. Assoc.* (1901): 283–288. ——

Erratic Blocks of the British Isles. Report of the Committee.

United Kingdom—Hertfordshire. **Tompkins.**

Highways and Byways in Hertfordshire. By Herbert W. Tompkins, with Illustrations by Frederick L. Griggs. London: Macmillan & Co., 1902. Size 8 × 5½, pp. xiv. and 348. *Map and Illustrations. Price* 6*s. Presented by the Publishers.*

This is one of the most pleasantly written of the volumes of the 'Highways and Byways' series. The author shows a keen appreciation of the quiet rural beauties which are the main charm of the county, and he gives some fascinating pictures of its woodlands, narrow winding lanes, and rich green meadows. The illustrations do their part well in presenting such scenes to the mind, and give many instances of the picturesque country churches and other architectural objects in the county.

United Kingdom—Humber. *Rep. B. Assoc.* (1901): 652–653. **Wheeler.**

The Source of Warp in the Humber. By W. H. Wheeler.

United Kingdom—London. ——

Census of England and Wales, 1901. County of London: Area, Houses, and Population; also Population classified by ages, condition as to marriage, occupations, birthplaces, and infirmities. London: Eyre & Spottiswoode, 1902. Size 13 × 8½, pp. xvi. and 176. *Map. Price* 1*s.* 9*d.*

United Kingdom—Meteorology. **Rambaut.**

Results of Meteorological Observations made at the Radcliffe Observatory, Oxford, in the eight years 1892–1899. Edited by Arthur A. Rambaut. Vol. xlviii. Oxford: J. Parker & Co., 1901. Size 10 × 6½, pp. xxiv. and 246. *Plates. Presented by the Trustees of the Radcliffe Observatory.*

United Kingdom—Scotland. *Rep. Brit. Assoc.* (1901): 720. **Smith.**

Methods and Objects of a Botanical Survey of Scotland. By W. G. Smith, B.SC.

United Kingdom—Scotland—Meteorology. **Buchan.**

J. Scottish Meteorolog. S. **12** (No. 17): 3–12, 12–20.

Fogs on the Coasts of Scotland. By Dr. Buchan. Storms on the Coasts of Scotland. By the same.

United Kingdom—Scotland—Shetland Islands. **Jakobsen.**

Aarb. Nord. Oldk. Hist. Kjøbenhavn **16** (1901): 55–258.

Shetlandsøernes Stednavne. Af Jakob Jakobsen.

A very thorough study of the place-names of the Shetlands.

United Kingdom—Temperature. ——

Temperature Tables for the British Islands. Daily Means for the Thirty Years 1871 to 1900, with Diagrams and Additional Tables. London: Eyre & Spottiswoode, 1902. Size 12½ × 10, pp. xiv. and 120. *Price* 10*s.* 6*d. Presented by the Meteorological Office.*

United Kingdom—Wales. *Quarterly J. Geolog. S.* **58** (1902): 207–225. **Strahan.**

On the Origin of the River-System of South Wales, and its Connection with that of the Severn and the Thames. By Aubrey Strahan. *With Map.*

This was noticed in the Monthly Record for July (p. 97).

ASIA.

Arabia. *Asien* **1** (1902): 127–129. **Schlagintweit.**

Die Mekkabahn. Von Major Max Schlagintweit. *With Map.*

Armenia. *Z. Ges. Erdk. Berlin* (1902): 290–292. **Rohrbach.**

Die abflusslosen Seen auf dem Armenischen Hochland. Von Dr. Paul Rohrbach.

The author urges the need of meteorological stations in Armenia in order to supply accurate data regarding the regime of the lakes and rivers.

Asia. **Wood.**

The Eastern World. A Commercial Geography for Pupil Teachers and Senior Students. By C. A. Wood. Bristol: Scholastic Trading Co. Size 8½ × 5½, pp. 16. *Maps. Price 6d. net.*

A short summary of facts relating to the commercial geography of the East.

Asia—Marco Polo's Travels. **Minaef.**

Zap. Imp. Russ. G.S. (Ethnog. Sec.) **26** (1902): pp. 356.

I. P. Minaef. Travels of Marco Polo. Translated from the old French text. [In Russian.]

Asia Minor. *Asien* **1** (1901): 43–45. **Körte.**

Kleinasien und der Westen im Altertum. Von Prof. Dr. A. Körte.

Central Asia. *Z. Ges. Erdk. Berlin* (1902): 333–335. **Hedin.**

Ueber die letzte Reise von Dr. Sven Hedin.

Ceylon—Veddahs. **Hiller and Furness.**

Notes of a trip to the Veddahs of Ceylon. By Dr. H. M. Hiller and Dr. W. H. Furness. Size 9 × 6, pp. 46. *Illustrations.*

China—Kiangsu. *Rev. G.* **50** (1902): 218–237. **Gadoffre.**

Le pays des canaux. Essai sur la province du Kiang-sou. Par Capitaine F. Gadoffre. *With Map.*

China—Manchuria. *G.Z.* **8** (1902): 185–204. **Immanuel.**

Die Mandschurei. Von Hauptmann Immanuel.

China—Manchuria. *Questions Dipl. et Colon.* 13 (1902): 548–552. **Bidou.**

Le règlement des affaires mandchouriennes. Par Henry Bidou. *With Map.*

China—Shensi. *Annuaire Club Alpin Français* **27** (1900): 356–382. **Leprince-Ringuet.**

En Chine. Ascension de la montagne sainte le T'aè-Houa-Chan. Par M. F. Leprince-Ringuet. *With Illustrations.*

China—Yunnan. **d'Anty.**

P. Bons d'Anty. Excursions dans le pays Chan Chinois et dans les Montagnes de Thé. (Série d'Orient No. 3.) Shanghai, 1900. Size 10 × 7½, pp. 66. *Map. Presented by the Author.*

Chinese Empire. *Iz. Imp. Russ. G.S.* **37** (1901): 233–353. **Kozloff.**

Account of the expedition of P. K. Kozloff. [In Russian.]

Chinese Empire. *La G., B.S.G. Paris* **5** (1902): 273–278. **Deniker.**

Voyage du Lieutenant Kozlov en Asie Centrale. Par J. Deniker. *With Map.*

French Indo-China—Annam. **Cadière.**

B. l'Ecole Française d'Extrême-Orient **2** (1902): 55–73.

Géographie historique du Quang Binh d'après les *Annales Impériales.* Par le R. P. Cadière. *With Sketch-maps.*

India. **Crosthwait and Roberts.**

Tide-Tables for the Indian Ports for the year 1902 (also January, 1903). By Captain H. L. Crosthwait and E. Roberts. 2 vols. Vol. i. Western Ports (Suez to Pámban Pass). Vol. ii. Eastern and Burma Ports (Galle to Port Blair). Size 6½ × 4, pp. (vol. i.) 1–611, (vol. ii.) 612–1204.

India—Botanical Survey. ——

Report of the Director of the Botanical Survey of India for the year 1900–1901. Size 13½ × 8½, pp. 24.

India—Marine Survey. ——

Administration Report of the Marine Survey of India for the official year 1900–1901. Bombay, 1901. Size 13 × 8½, pp. 8. *Presented by the Survey.*

India—Punjab. ——

Report on the Administration of the Punjab and its Dependencies for 1900–1901. Lahore, 1902. Size 13 × 8½, pp. xiv., 10, 170, and cexlvi. *Map and Diagram.*

India—Sanjân. *J. Bombay Br. R. Asiatic S.* **21** (1901): 4–18. **Modi.**

The ancient name of Sanjân. By Jivanji Jamshedji Modi, B.A.

The writer holds that the small town of Sanjân, near Bombay, is not the Sindan of the Arab geographers, which is rather to be placed in Cutch, but is the same as the Hanjamana of documents of the tenth and eleventh centuries.

India—Santals. *Norske G. Selsk. Aarbog* **12** (1900–1901): 24–49. **Bodding.**

Santalfolket i fortid og nutid af missionspræst P. O. Bodding. *With Illustrations.*

On the traditions, customs, etc., of the Santals.

Indian Ocean—Cocos Islands. **Carter.**

Cocos Islands. Report for 1901. Colonial Reports, Annual No. 352, 1902. Size 9½ × 6, pp. 20. *Price* 1½*d.*

Since 1885 the population has increased from 516 to 671, but a much larger increase is needed to make the islands independent of the outside labour market.

Indian Ocean—Maldive Islands. *American J. Sci.* **13** (1902): 297–308. **Agassiz.**

An Expedition to the Maldives. By Alexander Agassiz.

An abstract was given in the *Journal* for April (vol. xix. p. 480).

Japan—Rainfall. *J.G., Tōkyō G.S.*, **13** (1901): 405–412, 461–467. **Nakagawa.**

On the Precipitation in the Japanese Islands. By Gensaburo Nakagawa. [In Japanese.]

Malay Archipelago—Borneo. *B.G.S. Philadelphia* **3** (1901): 51–64. **Hiller.**

Manners and Customs of the People of Southern Borneo. By H. M. Hiller. *With Illustrations.*

Malay Archipelago—Borneo. ———

Tijds. K. Ned. Aard. Genoots. Amsterdam **19** (1902): 414–416.

Bij de kaart van het Boven-Mahakam-gebied. *With Map.*

The map, based on the work of Dr. Nieuwenhuis, shows the upper basin of the Mahakam.

Malay Archipelago—Celebes. **Rijn.**

Tijds. K. Ned. Aard. Genoots. Amsterdam **19** (1902): 328–372.

Tocht naar de Boven-Sadang (Midden-Celebes). Door A. P. van Rijn. *With Map.*

The Sadang enters the Strait of Macassar just north of 4° S.

Malay Peninsula. *J.S. Arts* **50** (1902): 570–587. **Smyth.**

Boats and Boat Building in the Malay Peninsula. By H. Warington Smyth. *With Illustrations.*

Malay Peninsula—Zoology. **Laidlaw and Skeat.**

P. Zoolog. S. 1901 (2) (1902): 575–586.

List of a Collection of Snakes, Crocodiles, and Chelonians from the Malay Peninsula, made by members of the "Skeat Expedition," 1899–1900. By F. F. Laidlaw, B.A. With an Appendix containing a list of the names of the places visited by the "Skeat Expedition." By W. W. Skeat. *With Plate.*

The appendix is of geographical interest as a guide to the true forms and pronunciation of Malayan place-names. As regards the system of orthography adopted, it could have been wished that *a* and *ai* had been used instead of *ĕ* and *ei* for the "indeterminate" vowel sound (*a* in "machine") and the English long *i* respectively.

Perim Island. *Geolog. Mag.* **9** (1902): 206–210. **Raisin.**

Notes on the Geology of Perim Island. By Catherine A. Raisin, D.SC. *With Section.*

Perim Island. *Rep. B. Assoc.* (1901): 640–641. **Raisin.**

Perim Island and its Relations to the Area of the Red Sea. By Catherine A. Raisin, D.SC.

Persia. *Z. Ges. Erdk. Berlin* (1902): 99–111. **Sarre.**

Reise in Mazenderan (Persien). Von Dr. F. Sarre. *With Illustrations.*

The journey was made in 1899, mainly for the study of the architectural monuments of the country.

Persia. **Sykes.**

Ten Thousand Miles in Persia or Eight Years in Irán. By Major Percy Molesworth Sykes. London: John Murray, 1902. Size 9½ × 6½, pp. xvi. and 482. *Map and Illustrations. Price 25s. net. Presented by the Publisher.*

This was reviewed in the July *Journal* (p. 92).

Philippine Islands. ———

Report of the Philippine Commission to the President. 4 vols. (Vol. i. pp. viii.

and 266); (vol. ii. pp. viii. and 496); (vol. iii. pp. 444); (vol. iv. pp. 418.) Washington, 1900–1901. Size 10 × 6. *Maps and Illustrations.*

Vol. i. deals especially with methods of government (past and prospective) in the Philippines; vol. ii. consists of the testimony given by witnesses before the Commission; and the bulk of vols. iii. and iv. is made up by a translation and adaptation of the papers prepared by the Jesuits of Manila, and already published in full in Spanish (cf. *Journal*, vol. xix. p. 619). There are, however, some additional papers, *e.g.* one by G. F. Becker on "Mineral Resources and Geology."

Russia—Caucasus. ——

Collection of Material for the description of Places and Tribes of the Caucasus. [xxix.] Tiflis, 1901. Size 9½ × 6½, pp. x., 148, 220, 96, 4, 162, and 62.

Russia—Siberia. *B.S.G. Com. Paris* **23** (1901): 514–529. **Labbé.**

La Situation des Provinces traversées par le Transsibérien. Par M. Paul Labbé.

Russia—Siberia. *Zap. Imp. Russ. G.S.*, Statist. Sec., **10** (1901): 1–366. **Plotnikoff.**

The Narim Country. Historical-Statistical Sketch. [A. F. Plotnikoff.] [In Russian.] *With Map.*

See note in the May *Journal* (p. 635).

Russia—Siberia and Manchuria. **Fraser.**

The Real Siberia; together with an account of a dash through Manchuria. By John Foster Fraser. London: Cassell & Co., 1902. Size 8 × 5, pp. xvi. and 280. *Map and Illustrations. Presented by the Publishers.*

This book, which records the personal impressions gained during a journey made last year across Siberia and Manchuria, aims at presenting to the general reader a picture of Siberia as it now is, since the period of modern development was ushered in by the advent of the railway. The author, who was reminded everywhere of Canada and the best parts of Western America, looks upon Siberia as the great food-producing region of the future.

Siam. *Rep. B. Assoc.* (1901): 411–424. **Skeat.**

Second Report on Cambridge Exploring Expedition to the Malay Provinces of Lower Siam, drawn up by W. W. Skeat.

Siam—Surveys. ——

Siam. General Report on the Operations of the Royal Survey Department, Season 1900–1901. Bangkok: Printed at "The American Presbyterian Mission Press," 1901. Size 13 × 8½, pp. 60. *Map, Plates, and Diagrams. Presented by the Royal Survey Department, Bangkok, Siam.*

Tibet—Flora. *J. Linnean S., Botany* **35** (1902): 124–265. **Hemsley.**

The Flora of Tibet or High Asia; being a Consolidated Account of the various Tibetan Botanical Collections in the Herbarium of the Royal Gardens, Kew, together with an Exposition of what is known of the Flora of Tibet. By W. Botting Hemsley, assisted by H. H. W. Pearson. *With Map. Also separate copy presented by the Author.*

This is noticed in the Monthly Record.

Turkey. *Globus* **81** (1902): 181–185. **Immanuel.**

Die Bagdadbahn. Ein deutsches Kulturwerk in Asien. Von Hauptmann Immanuel. *With Map.*

Turkey. *M.K.K.G. Ges. Wien* **45** (1902): 15–17. **Schaffer.**

Die Bagdadbahn. Von Dr. Franz Schaffer.

Turkey—Babylonia. **Wagner.**

Die Ueberschätzung der Anbaufläche Babyloniens und ihr Ursprung. Methodische Bedenken von Hermann Wagner. (Aus den Nachrichten der K. Gesellschaft der Wissenschaften zu Göttingen. Philologisch-Historische Klasse. 1902. Heft 2.) Size 9½ × 6½, pp. 224–298. *Maps.*

Turkey—Palestine. **Masterman.**

Palestine Exploration Fund, Quarterly Statement (1902): 160–167.

'Ain el-Feshkbah, el-Ḥajar, el-Aṣbah, and Kh. Ḳumrân. By Dr. E. W. G. Masterman. *With Map and Illustrations.*

Turkey—Palestine—Dead Sea. **Masterman.**
Palestine Exploration Fund, Quarterly Statement (1902): 155–160.
Observations of the Dead Sea Levels. By Dr. E. W. G. Masterman.
This is noticed in the Monthly Record for July.

Turkey—Syria. **Bliss.**
Palestine Exploration Fund, Quarterly Statement (1902): 168–175.
The German Excavations at Ba'albek. By F. J. Bliss, PH.D. *With Plan and Illustration.*

AFRICA.

Africa—Railways. *Export* **24** (1902): 197–199, 209–210, 221–223, 233–234. ——
Das tropische Afrika und Seine Eisenbahnen.

Algerian Sahara. *B.S.G. Marseille* **25** (1901): 267–273. **Lahache.**
Le Gouffre d'Aïn-Taïba, Sahara. Par le Dr. J. Lahache. *With Map.*
The Ain-Taiba is the only known source of water-supply, above ground, in the eastern region of dunes, south of Algeria.

Azores. *Tijds. K. Ned. Aard. Genoots. Amsterdam* **19** (1902): 235–265. **Verschuur.**
De Azorische eilanden. Door G. Verschuur.
Account of a visit to the group.

British East Africa—Murchison Falls. *Nature* **66** (1902): 188–189. **Betton.**
The Murchison Falls. By C. Steuart Betton.

British East Africa—Ruwenzori. *Alpine J.* **21** (1902): 77–90. **Moore.**
First Ascent of one of the Snow Ridges in the Mountains of the Moon. By J. E. S. Moore. *With Illustrations.*

Central Africa. *Deutsch. Kolonialzeitung* **19** (1902): 231–232, 245–246. **Schwartz.**
Eine Besteigung des Vulkans Kirunga tscha Niragongwo. Von W. Schwartz.
This will be noticed in the Monthly Record.

Central Africa. *J. African S.* (1902): 358–367. **Spilsbury.**
The Development of Central Africa from the East. By Major A. Gybbon Spilsbury.

Central Africa—Lake Rivu. **Bockelmann.**
Beiträge Kolonialpolitik u. Kolonialwirtschaft **3** (1901–1902): 357–380.
Versuch einer Monographie des Kiwu-Sees und seiner Umgebung als Begleittext zu Dr. Kandt's Karte. Von A. V. Bockelmann. *With Map.*
See note in the July *Journal* (p. 103).

Central Africa—Lakes. *P. Zoolog. S.*, 1901 (2) (1902): 461–470. **Moore.**
Further Researches concerning the Molluscs of the Great African Lakes. By J. E. S. Moore. *With Plates.*

Central Sudan. *Globus* **81** (1902): 373–375. **Singer.**
Die Dreiländerecke am Tschadsee. Eine Kolonialpolitische Betrachtung. Von H. Singer.

Congo State. **Lemaire.**
Mission Scientifique du Ka-Tanga. Observations altimétriques. Note sur les déterminations d'altitude. Tableau définitif des altitudes déterminées du mois d'août 1898 au mois de mai 1900. Table unique pour le calcul des altitudes de 0 mètre à 2100 mètres, dans les régions comprises entre 12° de latitude Nord et 12° de latitude Sud. Par le Capitaine Lemaire Charles. Seizième Mémoire. Size 13 × 10, pp. 56. *Presented by the Author.*
This will be specially noticed.

East Africa. *M.K.K.G. Ges. Wien* **45** (1902): 22–24. **Wickenburg.**
Reise des Grafen Wickenburg.
A short account of the journey was given at p. 216 of vol. xix. of the *Journal.*

Egypt—Cairo. **Lane-Poole.**
The Story of Cairo. By Stanley Lane-Poole. London: J. M. Dent & Co., 1902. Size 7 × 4¼, pp. xx. and 340. *Map and Illustrations. Price* 4*s.* 6*d. net. Presented by the Publishers.*
One of a most tastefully got-up series of little volumes on famous mediæval towns. It is embellished by reproductions of old drawings (with some modern ones), which

are a decided help towards realizing the aspect of the city before the advent of modern influences. The name of the author is a guarantee of the accuracy and interest of the text, which is both descriptive and historical. A table of the rulers and monuments of Cairo is given at the end, and another for the conversion of Mohammedan dates into those of the Christian era.

Egypt—Nile. *C. Rd.* **134** (1902): 1091–1092. **Lortet and Hugounenq.**

Coloration noire des rochers formant les cataractes du Nil. Note de MM. Lortet et Hugounenq.

Eritrea. *Ann. G.* **11** (1902): 153–168. **Saint-Yves.**

A travers l'Erythrée Italienne, les confins de l'Abyssinie et du Soudan. Par G. Saint-Yves.

French Congo. *B.S.G. Com. Paris* **23** (1901): 489–513. **Bobichon.**

La colonisation du Haut-Oubangui. Par M. Henri Bobichon.

French Congo. *La G., B.S.G. Paris* **5** (1902): 216–218. **Julien.**

Exploration du capitaine Julien de la haute Banghi à la Yéouka et le long de l'Oubanghi.

French West Africa. *La G., B.S.G. Paris* **5** (1902): 165–174. **Bruel.**

La région civile du Haut-Chari. Par G. Bruel. *With Map.*

French West Africa. *La G., B.S.G. Paris* **5** (1902): 155–164. **Robillot.**

Reconnaissance et organisation du Bas-Chari. Par Commandant Robillot.

Ivory Coast. *B.S.G. Lyon* **17** (1902): 632–643. **Cassel.**

La Haute Côte d'Ivoire Occidentale. Conférence par M. van Cassel.

Ivory Coast. *La G., B.S.G. Paris* **5** (1902): 241–246. **Clozel.**

Jonction des lagunes d'Assinie et de Grand-Bassam, Côte d'Ivoire. Par M. Clozel. *With Map.*

The writer's survey of the coast-region between Assini and Grand-Bassam has shown the feasibility of the connection of the lagoons by a navigable channel.

Kamerun. *Deutsch. Kolonialblatt* **13** (1902): 215–218. **Stein.**

Expedition des Freiherrn v. Stein. *With Map.*

Continues the account of the return journey to the Ngoko station (cf. *Journal*, vol. xix. pp. 218, 638).

Komoro Islands. *B.S.G. Com. Paris* **23** (1901): 579–606. **Repiquet.**

Le Sultanat d'Anjouan, une de nos colonies de la côte de Mozambique. Par M. J. V. Repiquet. *With Map.*

Madagascar. ———

Madagascar au début du XX^e^ Siècle. Paris: F. R. de Rudeval et Cie., 1902. Size 10 × 6½, pp. vi. and 466. *Maps and Illustrations. Price* 20 *fr. Presented by the Publishers.*

This will be reviewed elsewhere.

Morocco. *Fortnightly Rev.* **71** (1902): 675–681. **Mackenzie.**

Morocco and the European Powers. By Donald Mackenzie.

Sahara. *C. Rd.* **134** (1902): 1322–1324. **Flamand.**

Sur la présence du Dévonien inférieur dans le Sahara occidental (Bas-Touat et Tidikelt, archipel touatien). Note de M. G. B. M. Flamand.

Transvaal—Geology. *La G., B.S.G. Paris* **5** (1902): 196–200. **Giraud.**

La Géologie du Transvaal. Par J. Giraud.

Based on Dr. Molengraaff's work (see below).

Transvaal—Geology. **Molengraaff.**

Géologie de la République Sud-Africaine du Transvaal. Par le Dr. G. A. F. Molengraaff. (Extrait du Bulletin de la Société Géologique de France.) Paris, 1901. Size 10 × 6½, pp. 92. *Map and Illustrations.*

The most complete account of the Geology of the Transvaal that has yet appeared. The author, whose geological explorations in Borneo are well known, was director of the Geological Survey of the Transvaal before the war, and has also given a summary of the geology of the country in the official report entered below.

Transvaal—Geology. **Molengraaff.**

Geological Survey of the South African Republic. Annual Report for the year

1898. By Dr. G. A. F. Molengraaff. [Translated from the Dutch.] Pretoria, 1902. Size 13 × 8½, pp. 46. *Maps and Sections.*

NORTH AMERICA.

Alaska. **Burroughs, Muir, Grinnell, and others.**

Alaska. Giving the results of the Harriman Alaska Expedition, carried out with the co-operation of the Washington Academy of Sciences. 2 vols. Vol. i. Narrative, Glaciers, Natives. By John Burroughs, John Muir, and George Bird Grinnell. Vol. ii. History, Geography, Resources. By William H. Dall, Charles Keeler, Henry Gannett, William H. Brewer, C. Hart Merriam, George Bird Grinnell, and M. L. Washburn. London: John Murray, 1902. Size 10½ × 7, pp. xl. and 384. *Maps, Plates, and Illustrations. Price* £3 3*s.* 0*d. net.*

This will be the subject of a special review.

Lake Erie. **Henry.**

Wind Velocity and Fluctuations of Water Level on Lake Erie. Prepared . . . by Prof. Alfred J. Henry. (U.S. Department of Agriculture, Weather Bureau, Bulletin J.) Washington, 1902. Size 11½ × 9½, pp. 22. *Chart and Diagrams. Presented by the U.S. Department of Agriculture.*

This was noticed in the Monthly Record for July.

United States. ——

U.S. Department of Agriculture, Weather Bureau. Report of the Chief of the Weather Bureau, 1899–1900. Washington, 1901. Size 12 × 9, pp. 436.

United States. ——

Annual Report of the Department of the Interior, 1899 [7 vols.]:—Report of the Secretary of the Interior. Report of the Commissioner of the General Land Office (1899, pp. cxlii. and 536); Indian Affairs, 2 vols. (1899, pp. — vol. i., viii. and 682; vol. ii., 750. *Maps and Illustrations*); Miscellaneous Reports, 2 vols. (1899, pp. — vol. i., 576; vol. ii., 882. *Plans and Illustrations*); Report of the Commissioner of Education, 2 vols. (1900, pp. xcii. and 2518. *Illustrations*). Size 9 × 6. Washington. *Presented by the U.S. Department of the Interior.*

United States—Arkansas. *J. Geology* **10** (1902): 160–165. **Hershey.**

Boston Mountain Physiography. By Oscar H. Hershey.

United States—Census. **Hunt.**

Census Reports. Volume i. Twelfth Census of the United States, taken in the year 1900. William R. Merriam, Director. Population, Part i. Prepared under the supervision of William C. Hunt, Chief Statistician for Population. Washington: United States Census Office, 1901. Size 12 × 9½, pp. ccxxx. and 1006. *Maps and Diagrams. Presented by the Director of the Census.*

The present part, which constitutes vol. i. of the census reports, treats of the population both in the aggregate and in detail by sex, general nativity, colour, place of birth, parentage, citizenship, and years in the United States. It has been completed and published in the short space of eighteen months since the enumeration was taken. The population report will be completed in a second volume.

United States—Food Production. **Atkinson.**

Food and Land Tenure. By Edward Atkinson. [Reprinted, with additions, from the *Popular Science Monthly*, October, 1901, vol. lix., No. 6.] Size 10 × 7, pp. 32.

The writer holds that "the theory that wheat-bread may be wanting during the present century for lack of land is absolutely unthinkable."

United States—Genesee River. *B. American G.S.* **34** (1902): 32–44. **Whitbeck.**

The Preglacial Course of the Middle Portion of the Genesee River. By R. H. Whitbeck. *With Map and Illustrations.*

United States—Geological Survey. ——

Annual Reports of the Department of the Interior for the fiscal year ended June 30, 1899. Twentieth Annual Report of the United States Geological Survey. Part i.—Director's Report, including Triangulation and Spirit Levelling. (Pp. 552. *Maps.*) Ditto. Part vi. (in 2 vols.). Mineral Resources of the United States, 1898. (Pp. 616 and 804. *Plate.*) Washington, 1899. Size 11½ × 8. *Presented by the U.S. Geological Survey.*

United States—Indiana. *J. Geology* **10** (1902): 166–181. **Newsom.**
Drainage of Southern Indiana. By J. F. Newsom. *With Map.*

United States—Klamath Mountains. *J. Geology* **10** (1902): 144–159. **Anderson.**
The Physiographic Features of the Klamath Mountains. By F. M. Anderson.

United States—Magnetic Survey. *National G. Mag.* **13** (1902): 92–95. **Bauer.**
Magnetic Survey of the United States. By Dr. L. A. Bauer. *With Chart.*

United States—Massachusetts. *P. Boston S. Nat. Hist.* **30** (1901): 353–374. **Wilson.**
The Medford Dike Area. By Alfred W. G. Wilson. *With Maps.*

United States—Negroes. **Atkinson.**
The Race Problem: its possible solution. By Edward Atkinson. Reprinted from Manufacturers' Record of Baltimore, of December 19, 1901. Size 9½ × 6, pp. 8.

The writer considers that the race-problem in the United States exists only where there is much illiteracy among both whites and blacks.

CENTRAL AND SOUTH AMERICA.

Central America – Interoceanic Routes. **Morrison.**
Library of Congress. List of Books and of Articles in Periodicals relating to Interoceanic Canal and Railway Routes (Nicaragua; Panama, Darien, and the Valley of the Atrato; Tehuantepec and Honduras; Suez Canal). By Hugh A. Morrison, jr. With an Appendix: Bibliography of the United States Public Documents. Washington, 1900. Size 9½ × 6, pp. 174.

Colombia. *Jahresb. G. Ges. München* (1900–1901): lxii.–lxv. **Regel.**
Ueber seine Reisen im Berglande von Antioquia (Kolumbien). Von Prof. Dr. F. Regel.

Guiana. *Petermanns M.* **48** (1902): 58–66. **Sievers.**
Der Grenzstreit zwischen Brasilien und Frankreich über Guayana. Von Prof. Dr. W. Sievers. *With Map.*

Patagonia. *Norske G. Selsk. Aarbog* **12** (1900–1901): 67–78. **Schjander.**
Fra det indre af Patagonien. Af Afdelings-Chef Nils Schjander.

Peru. *B.S.G. Lima* **11** (1901): 212–219. **Duval and Quartel.**
Ferrocarril de Paita al Marañón. Por A. Duval y Pedro J. de Quartel.

Peru. *Norske G. Selsk. Aarbog* **12** (1900–1901): 50–66. **Markham.**
Geographical Aspects of Inca Civilization. Af Sir Clements Markham.

A paper read at the Norwegian Geographical Society in 1900, tracing the influence of geographical conditions on the inhabitants of Peru.

Peru. *B.S.G. Lima* **11** (1901): 164–174. **Raéz.**
Itinerario de Huancayo á Lunahuaná. Por Nemesio A. Raéz.

South America. *Norske G. Selsk. Aarbog* **12** (1900–1901): 79–95. **Martens.**
Fra det indre af Syd-Amerika, af Yngvar Martens. *With Illustration.*

Deals chiefly with the "Guayaquil" Indians of the borders of Argentina, Paraquay, and Brazil.

AUSTRALASIA AND PACIFIC ISLANDS.

Pacific Ocean—Cable. **Clark, Ford, and Taylor.**
Pacific Cable. Engineers' Report on the Selection of Landing Places, Sites for Stations, etc., and on the Survey of the Route for the Cable. Size 15½ × 11, pp. 98. *Charts and Illustrations. Presented by the Authors.*

This report contains as an appendix the complete log of the soundings taken during Mr. Peake's survey, the chief scientific results of which were summarized by Sir John Murray in the June number of the *Journal.*

Queensland. **Jack.**
Artesian Water in the State of Queensland, Australia. By Dr. R. Logan Jack. (Read before the Victoria Institute.) 1902. Size 8½ × 5½, pp. 16. *Diagram. Presented by the Author.*

Savage Island. **Thomson.**

Savage Island, an Account of a Sojourn in Niué and Tonga. By Basil Thomson. London: John Murray, 1902. Size 8½ × 5½, pp. viii. and 234. *Map and Illustrations. Price 7s. 6d. net. Presented by the Publisher.*

Mr. Thomson went officially to Niue in 1900, when negotiating a British Protectorate over Tonga, and in the present work supplies a welcome addition to our knowledge of that rarely visited island.

South Australia—Meteorology. **Todd.**

1897. Meteorological Observations made at the Adelaide Observatory and other places in South Australia and the Northern Territory during the year 1897, under the direction of Charles Todd. Adelaide: C. E. Bristow, 1900. Size 13 × 8½, pp. xiv. and 78. *Maps.* Ditto during the year 1898. Pp. xvi. and 82. *Maps. Presented by the Government Astronomer.*

Tasmania. *Rev. of Reviews, Australasia* **18** (1901): 199–220. **Shum and Ussher.**

Tasmania at the Beginning of the Century. By W. A. Shum and Lancelot H. Ussher. *With Illustrations.*

Victoria—Statistics. **Fenton.**

Victorian Year-Book, 1895–8. Containing a Digest of the Statistics of Victoria, with references to the Statistics of the other Australasian Colonies and other Countries. By J. J. Fenton. Melbourne: R. S. Brain; London: Paul & Co., 1901. Size 8½ × 5½, pp. 8, xviii., ii., 1132, and ccxxxvi. *Map.*

Western Australia. **Clifton.**

Western Australia. Department of Lands and Surveys. Report by the Under Secretary for Lands for the year 1900. Perth, 1901. Size 13½ × 8½, pp. 60. *Presented by the Minister for Lands, Western Australia.*

Western Australia. **Johnston.**

Western Australia. Department of Lands and Surveys. Report by the Surveyor-General for the year 1900. Perth, 1901. Size 13½ × 8, pp. 16. *Maps and Plans. Presented by the Minister for Lands, Western Australia.*

POLAR REGIONS.

Antarctic—Twilight. *Ciel et Terre* **23** (1902): 68–79. **Arctowski.**

Note sur les phénomènes crépusculaires observés à bord de la "Belgica." Par Henryk Arctowski.

Arctic. *A travers le Monde, Tour du Monde* **8** (1902): 109–111. **Stein.**

Deux années dans les régions arctiques.—Journal du docteur Robert Stein. *With Map.*

Arctic—Botany. *Vierteljahrs. Naturforsch. Ges. Zürich* **46** (1901): 300–322. **Rikli.**

Die pflanzlichen Formationen der Arktis. Von M. Rikli. *With Profile.*

Arctic—Norwegian Expedition. **Nansen.**

The Norwegian North Polar Expedition, 1893–1896. Scientific Results edited by Fridtjof Nansen. Vol. iii. Published by the Fridtjof Nansen Fund for the Advancement of Science. London, etc.: Longmans & Co, 1902. Size 11½ × 9, pp. xii., 428, and 88. *Maps and Diagrams. Two copies, one presented by the Fridtjof Nansen Fund, the other by Messrs. Longmans & Co.*

A review of this will be given.

Arctic—Russian Expedition. *Petermanns M.* **48** (1902): 66–68. **Toll.**

Russische Polarexpedition unter Leitung von Baron Ed. Toll. Bericht über die Fahrt der "Sarja" durch die Kara-See und über die Arbeiten des Jahres 1900. Von Eduard v. Toll.

Greenland. **Moltke.**

Meddelelser om Grønland, udgivne af Commissionen for Ledelsen af de geologiske og geographiske Undersøgelser i Grønland. Farvetrykt Bilag til Hefte XXIV. Harald Moltke: Nordkysten af Vajgat i Nord-Grønland. Kjøbenhavn: C. A. Reitzel, 1901. Size 7½ × 11.

A panorama of the coast-line.

PHYSICAL AND BIOLOGICAL GEOGRAPHY.

Meteorology. **Marriott.**

Hints to Meteorological Observers. Instructions for taking Observations, and Tables for their Reduction, together with a Glossary of Meteorological terms. Prepared under the direction of the Council of the Royal Meteorological Society, by William Marriott. Fifth edition. London: E. Stanford, 1902. Size 10 × 6½, pp. 60. *Illustrations.* *Price* 1*s.* 6*d.*

Oceanography. *Rev. Scientifique* **17** (1902): 1–12, 40–49, 138–145. **Monaco.**

Le dernier voyage scientifique de "l'Hirondelle." Par Albert, Prince de Monaco.

Oceanography. **Townsend.**

U.S. Commission of Fish and Fisheries. Dredging and other Records of the United States Fish Commission Steamer *Albatross*, with Bibliography relative to the work of the vessel. Compiled by C. H. Townsend. (Extracted from U.S. Fish Commission Report for 1900. Pp. 387–562.) Washington, 1901. Size 9 × 6. *Charts and Plates.*

The records of observations connected with the dredging, sounding, and other scientific operations carried out on board the *Albatross* since 1883 are here brought together from the yearly reports, etc., of the United States Fish Commission. The bibliography of books and papers dealing more or less directly with the work of the *Albatross* contains over 230 entries.

Oceanography—Currents. *National G. Mag.* **13** (1902): 135–142. **Page.**

Ocean Currents. By James Page.

Oceanography—Norwegian Expedition. **Friele and Grieg.**

The Norwegian North-Atlantic Expedition, 1876–1878. XXVIII. Zoology. Mollusca iii. By Herman Friele and James A. Grieg. Chemical Examination of Shells of Mollusca and of Dried Echinoderms. By L. Schmelck. Christiania, 1901. Size 15 × 11½, pp. viii. and 128. *Maps.* *Presented by the Editorial Committee.*

Phyto-Geography. **Bretzl.**

Botanische Forschungen des Alexanderzuges, nach Theophrasts Auszügen aus den griechischen Generalstabsberichten. Inaugural-Dissertation . . . vorgelegt von Hugo Bretzl. Strassburg, 1902. Size 9 × 6, pp. 42. *Presented by the Author.*

The writer shows how the campaigns of Alexander, by familiarizing the Greeks with new climatic regions, gave the first impetus to the study of botanical geography.

Phyto-Geography. *Scottish G. Mag.* **18** (1902): 225–236. **Hardy.**

Botanical Geography and the Biological Utilisation of the Soil. By Marcel Hardy.

Zoogeography—Birds. *Deutsche Rundschau G.* **24** (1902): 306–310. **Floericke.**

Die Wanderungen der Vögel. Von Dr. Curt Floericke. *With Map.*

This was noticed in the Monthly Record for July.

ANTHROPOGEOGRAPHY AND HISTORICAL GEOGRAPHY.

Commercial Geography—Pecan. *J.G.* **1** (1902): 102–109. **Littlejohn.**

The Pecan. Its culture and commercial value. By E. G. Littlejohn. *With Map and Illustrations.*

The pecan is the nut of *Carya olivæformis*, which is said to offer great advantages as an article of food.

Historical. *Mouvement G.* **19** (1902): 211–216, 223–227. ——

La fondation de la Compagnie d'Ostende (1723).

Les expéditions de la Compagnie d'Ostende.

Historical—Behaim. *Rep. B. Assoc.* (1901): 714–715. **Ravenstein.**

Martin Behaim of Nürnberg, 1459–1507. By E. G. Ravenstein.

Historical—Magellan. **Grifoni.**

U. Grifoni. Magellano scoprì lo stretto che porta il suo nome? (Rivista Marittima. Estratto dal fascicolo di ottobre 1901.) Roma, 1901. Size 8½ × 6, pp. 22. *Presented by the Author.*

An attempt to belittle Magellan's achievement by showing that notions as to his strait were current before his voyage.

Historical—Toscanelli and Columbus. *Ann. G.* **11** (1902): 97–110. **Gallois.**

Toscanelli et Christophe Colomb. Par L. Gallois.

A critical analysis of M. Vignaud's arguments put forward in his recent work.

Historical—Toscanelli and Columbus. **Marcel.**

La G., B.S.G. Paris **5** (1902): 267–272.

Toscanelli et Christophe Colomb d'après un ouvrage récent. Par Gabriel Marcel.

A critical examination of the thesis lately put forward by M. Vignaud.

Piracy. *Nautical Mag.* **71** (1902): 205–214. **Stephens.**

Piracy from the Thirteenth to the Eighteenth Century. By J. E. R. Stephens.

Soil. *Popular Sci. Monthly* **60** (1902): 539–550. **Cameron.**

The Soil as an Economic and Social Factor. By Frank K. Cameron.

BIOGRAPHY.

Holub. *Deutsche Rundschau G.* **24** (1902): 327–329. ——

Dr. Emil Holub. *With Portrait.*

Mushketoff. *Deutsch. Rundschau G.* **24** (1902): 280–282. **Stenin.**

Iwan Wassiljewitsch Muschketoff. Von Peter v. Stenin. *With Portrait.*

Nordenskiöld. *Ymer* **22** (1902): 109–303. **Wieselgren and others.**

Åt minnet af A. E. Nordenskiöld. *With Portrait, Maps, and Illustrations.*

Mr. Wieselgren gives a general biographical sketch of the late Baron Nordenskiöld, Dr. Nathorst deals with his polar voyages and geological work, Mr. Sjögren with the mineralogical, and Mr. Dahlgren with his researches in historical geography and cartography. A bibliography of all his published writings is added by Mr. Hulth.

Tomaschek. *M.K.K.G. Ges. Wien* **45** (1902): 3–14. **Bittner.**

Wilhelm Tomaschek. Von Prof. Dr. Maximilian Bittner.

GENERAL.

Asia and America. *Petermanns M.* **48** (1902): 49–58. **Immanuel.**

Nordwest-Amerika und Nordost-Asien. Geographische Wechselbeziehungen. Von Hauptmann Fr. Immanuel. *With Map.*

Some of the statements in this article are severely criticised in *Science* by Mr. A. H. Brooks, one of the V.S. Geological Survey explorers of Alaska.

Bibliography. **Berg.**

Die wichtigste geographische Litteratur. Ein praktischer Wegweiser von Dr. Alfred Berg. Halle a. S., Gebauer-Schwetschke Druckerei u. Verlag, 1902. Size 8½ × 5½, pp. 76. *Presented by the Publisher.*

Being intended chiefly for German readers, the number of books in other languages referred to is extremely limited. Thus, under Sahara, no mention is made of Schirmer's work.

Coins. **Macdonald.**

Catalogue of Greek Coins in the Hunterian Collection, University of Glasgow. Volume ii. North-Western Greece, Central Greece, Southern Greece, and Asia Minor. By George Macdonald. Glasgow: J. Maclehose & Sons, 1901. Size 12 × 9, pp. viii. and 650. *Plates. Presented by the Publishers.*

Educational. *Z. Ges. Erdk. Berlin* (1902): 112–142. **Fischer.**

Zur Methodik des erdkundlichen Schulunterrichts. Von H. Fischer.

Education—Text-books. **Wölfel.**

Bemerkungen zu geographischen Lehr- und Schulbüchern, Karten, etc. Von Dr. Phil. E. J. Wölfel. Freiberg: Gerlachsche Buchdruckerei, 1902. Size 10 × 8, pp. 32. *Presented by the Author.*

German Colonies. **Buchanan.**

Report on German Colonies for the year 1900–1901. Foreign Office, Annual No. 2790, 1902. Size 9½ × 6, pp. 30. *Price 2d.*

Local Geography. *Eastern Counties Mag.* **2** (1902): 329–334. **Mill.**

The Study of Local Geography. By Dr. H. R. Mill.

Malaria. **Stephens and Christophers.**

Reports to the Malaria Committee of the Royal Society. Sixth Series. Reports from Messrs. Stephens and Christophers, Bengal. London: Harrison & Sons, 1902. Size 8½ × 5½, pp. 24. *Maps, Plans, and Illustrations. Price* 1*s. Presented by the Royal Society.*

See note in the June *Journal* (p. 753).

North America and Asia. *National G. Mag.* 13 (1902): 86–92. **Baker.**

Sarichef's Atlas, 1826. By Marcus Baker.

Royal Society—Year-Book.

Year-Book of the Royal Society of London, 1902. London: Harrison & Sons, 1902. Size 8½ × 5½, pp. 266. *Presented by the Royal Society.*

Science and Time. **Ratzel.**

Die Zeitforderung in den Entwickelungswissenschaften. (Abgedruckt aus Ostwald's Annalen der Naturphilosophie Erster Band.) Leipzig: Veit & Comp. Size 9 × 6, pp. 309–363. *Presented by the Author.*

The writer regards the sciences which deal with development as bound together by their common relation to time, the determination of which is their primary task. Among them he lays stress on the distinction between sciences based on time-reckoning and those based on mere estimates of time.

Steamship Guide. **Rhodes.**

1902–3. Rhodes's Steamship Guide. Edited by Thomas Rhodes. London: G. Philip & Son. Size 7 × 5, pp. 494. *Illustrations. Price* 2*s. Presented by the Publishers.*

Contains a large amount of practical information for intending voyagers, though not quite complete as regards the means of communication with some of the more remote ports, especially in the Pacific. The Gazeteer of Ports does not always give the necessary references. Thus no clue is to be found to the information on p. 126 as to the Belgian steamers to the Congo.

Year-Book. **Klein.**

Jahrbuch der Astronomie und Geophysik. Enthaltend die wichtigsten Fortschritte auf den Gebieten der Astrophysik, Meteorologie und physikalischen Erdkunde. Unter Mitwirkung von Fachmännern herausgegeben von Dr. Hermann J. Klein. XII. Jahrgang, 1901. Leipzig: E. H. Mayer, 1902. Size 9 × 5½, pp. viii. and 416. *Maps and Illustrations.*

Year-Book. **Wagner.**

Geographisches Jahrbuch. XXIV. Band, 1901 . . . herausgegeben von Hermann Wagner. Zweite Hälfte. Gotha: Justus Perthes, 1902. Size 8½ × 6, pp. 249–444. *Price* 7.50 *m.*

This part is devoted mainly to recent work in the geography of plants and animals, but includes also a useful report by Hauptmann Kollm on the geographical societies of the world, supplementing that issued in 1896.

NEW MAPS.

By E. A. REEVES, *Map Curator*, R.G.S.

EUROPE.

England and Wales. **Ordnance Survey.**

Ordnance Survey of England and Wales:—Revised sheets published by the Director-General of the Ordnance Survey, Southampton, from June 1 to 30, 1902.

1-inch:—

Towns and country around, or districts, with lakes and roads printed in colour. The Lake District, West. 1*s.* 6*d.*

6-inch—County Maps:—

Cambridgeshire, 14 S.W., S.E., 19 N.E., 20 N.W., S.W. **Huntingdonshire,** 1 (N.E. and S.E.), 2 S.W., 4 S.E., 5 N.W., N.E., S.E., 6 S.W., S.E., 9 N.E., S.W., S.E., 10 N.E., S.W., S.E., 11 N.W., S.W., 12 N.E., 13 N.W., S.W., S.E., 14 N.W., N.E., 15 N.W., 16 N.E., 17 N.E., S.W., S.E., 18 N.W., S.W., S.E., 19 N.W., 20 N.E., 21 S.W., 22 N.W., 24 N.E., 25 N.W., S.W. **Monmouthshire,** 1 S.E., 6 S.E., 12 S.E., 28 N.E., 29 S.W., 35 N.W. (35 N.E. and 36 N.W.), 35 S.W. (36 N.W. and 35 N.E.). **Wiltshire,** 74 S.W. 1*s. each.*

25-inch—County Maps:—

Cambridgeshire, I. 14; XXII. 5, 7; XXV. 8, 15. **Dorsetshire,** XXXI. 3, 8; XXXII. 6, 13, 14; XLI. 1, 9, 15; XLVIII. 3, 8, 11, 12; XLIX. 6, 14; LIV. 2, 3; LV. 2. **Gloucestershire,** IX. 4, 8. 16; X. 5, 9, 10, 13, 14; XI. 10, 11, 15 16; XII. 7; XIX. 8, 9, 13; XX. 13; XXV. 14; XXX. 16; XXXV. 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13; XXXVII. 10. **Montgomeryshire,** XXIII. 8, 9, 13; XXIV. 1, 2; XXIX. 10, 11, 12, 13; XXXVI. 3, 5, 7. **Shropshire,** XXXI. 14, 15; XXXII. 16; XXXIII. 14; XXXIV. 2, 4, 5, 8; XXXV. 9; XXXVII. 1, 2, 3, 5, 6; XXXIX. 2, 3, 4, 7, 8, 11, 12; XL. 1, 3, 5 **Staffordshire,** L. 1, 2, 6, 9, 10, 14; LI. 7, 8. 9, 12, 14; LII. 5, 13; LIX. 3, 5, 6. **Worcestershire,** LIV. 9 (Areas of Eldersfield, Pendock (Det.) and Redmarley D'Abitôt Parishes only), 10 (Areas of Eldersfield and Pendock (Det.) Parishes only), 15, 16 (Area of Chaceley Parish only); LV. 7. **Yorkshire,** CCXCVI. 16; CCXCIX. 8; CCCI. 1. 3*s. each.*

4 miles to 1 inch:—

District Maps:—With roads printed in colour (Northampton), 1*s.*, folded in cover or flat in sheets.

(E. Stanford, London Agent.)

Austria. **Petermanns Geographische Mitteilungen.**

Kartenskizze der Umgebung des Fadingersattels. Scale 1 : 75,000 or 1·1 stat. miles to an inch. *Petermanns Geographische Mitteilungen*, Jahrgang 1902. Tafel 11. Gotha: Justus Perthes. *Presented by the Publisher.*

ASIA.

Japan. **Japanese Government.**

Government Survey of Japan. Scale 1 : 50,000 or 0·08 stat. miles to an inch. The Survey Department, Tokio. *Presented by K. Otani, Esq., Tokio.*

These sheets of the Japanese Survey include areas from 60 to 70 miles to the north and west of Kioto. Relief is shown by an elaborate system of contour lines, and a considerable amount of detail is given. The lettering is in native characters.

Korea. **Ministry of Finance, St. Petersburg.**

Map of Korea. Scale 1 : 355,000 or 21·2 stat. miles to an inch. Ministry of Finance, St. Petersburg, 1900. In Russian character. A. Ilyin, St. Petersburg.

This map has been compiled from the latest material up to the date of its issue. It is printed in colours—hills brown, water blue, boundaries red and green, and lettering black. In addition to the principal map there are five insets of ports, bays, etc., and a small-scale geological map of Korea.

Tibet. **Koslow.**

Schematische Darstellung der Reiseroute Koslows im östlichen Tibet, 1900. Scale 1 : 3,500,000 or 55·2 stat. miles to an inch. *Petermanns Geographische Mitteilungen*, Jahrgang 1902. Tafel 13. Gotha: Justus Perthes. *Presented by the Publisher.*

AFRICA.

Africa. **Intelligence Division, War Office.**

Africa. Scale 1 : 1,000,000 or 15·7 stat. miles to an inch. Sheets: 63, Yola; 68, North-West Somaliland. 1901. *Price* 2*s. each.* London: Intelligence Division, War Office. Stanford. *Presented by the Director-General of Mobilization and Military Intelligence.*

Congo Free State—Lake Kivu. **Kandt.**

Karte des Kiwu Sees. Von Dr. R. Kandt. Scale 1 : 285,000 or 4·4 stat. miles to an inch. Berlin: Wilhelm Süsserott, 1902.

This map of Lake Kivu is reduced from the recent surveys of Dr. R. Kandt, concerning which various notes have appeared in the *Geographical Journal* during the last two or three years. Although differing in detail, the map agrees fairly well, as regards its general features, with the survey of the lake made in 1899–1900 by Mr. M. Fergusson, of Mr. Moore's expedition. The principal differences are noticeable in the bays and indentations of the shore-line, and in the form and direction of the large island of Kwijwi. No soundings are given, nor is there any indication of latitude and longitude. The text, by A. von Bockelmann, which accompanies the map is principally an account of the explorations of other travellers, and of the general physical features and characteristics of the neighbourhood. It would have been well if fuller information had been given as to the method of survey.

German East Africa. **Sprigade and Nobiling.**

Karte von Deutsch-Ostafrika. Scale 1 : 300,000 or 4·7 stat. miles to an inch. Sheet F 6 Kilwa. Bearbeitet von P. Sprigade, gezeichnet von H. Nobiling. Berlin : D. Reimer (Ernst Vohsen), 1901.

The area included in this sheet of the large-scale map of German East Africa extends from 8° 30′ to 10° S. lat., and from 38° to 40° E. long. Apart from the country in the neighbourhood of the coast, very little of this district is explored or at all properly mapped. The sheet is accompanied by letterpress, giving a list of the authorities from which it has been compiled.

AMERICA.

United States. **Rand, McNally & Co.**

Indexed County and Township Pocket Map of Iowa, Scale 1 : 823,680 or 13 stat. miles to an inch; Kansas, Scale 1 : 1,013,760 or 16 stat. miles to an inch; Kentucky, Scale 1 : 1,140,480 or 18 stat. miles to an inch. Chicago and New York: Rand, McNally & Co. *Price* $0.25 *each. Presented by the Publishers.*

These are new editions of Rand, McNally & Co.'s useful series of maps of the United States.

West Indies—Martinique. **Petermanns Geographische Mitteilungen.**

Martinique. Nach der offiziellen französischen Karte in 1 : 80,000 reduziert auf den Massstab 1 : 200,000 or 3·1 stat. miles to an inch. *Petermanns Geographische Mitteilungen*, Jahrgang 1902. Tafel 12. Gotha: Justus Perthes. *Presented by the Publisher.*

GENERAL.

World. **Bartholomew.**

Atlas for South African Schools. A new series of physical and political maps. By J. G. Bartholomew, F.R.G.S. Fourth and enlarged edition. Cape Town, Bulawayo, and Paarl: T. Maskew Miller.

This is a new and enlarged edition of a general atlas which was prepared some years ago at the suggestion of Dr. Muir, the Superintendent-General of Education for Cape Colony. Recent events in South Africa have rendered considerable alterations necessary, although even now no attempt has been made to show the new frontier of Natal. In its present form the atlas consists altogether of forty-eight sheets of maps, of which thirteen have special reference to South Africa. The maps of the continents are in pairs—physical and political—on the same scale, and facing each other. There are six sheets devoted to the world as a whole, illustrating physical features, meteorology, and distribution of the human race.

World. **Berndt.**

Die Concurrenz-Verhaltnisse am Weltmarkt. Percentueller Antheil der bedeutendsten Handelsstaaten am Gesammt-Handel aller Länder der Erde. Auf Grund officieller Daten nach dem Durchschnitt der letzten 3 Jahre dargestellt von Wilhelm Berndt. Wien: G. Freytag & Berndt.

This sheet measures about 27 × 35 inches, and its centre is occupied by a large general map of the world on Mercator's projection, showing steamer routes with distances in time between the principal ports, important railways, and, by means of figures, the amount of the imports and exports of each country. These figures are clearly printed in blue upon or near the various countries, in the form of a vulgar fraction, of which the numerator represents the imports, and the denominator the exports. In addition to this general map there are six small insets of the world, also on Mercator's projection, showing, by means of different tints, the percentage of the trade of the United States and some of the more important European countries to the whole trade of the world. The European countries represented are Great Britain, Germany, Netherlands, France, and Austria-Hungary. The information has been obtained from the official reports of the last three years, and altogether the map is most instructive, and will prove useful in the study of commercial geography.

World. **Freytag.**

G. Freytag: Export-Atlas für Welthandel und Industrie. Statistische Darstellung der Ein- und Ausfuhr aller wichtigen Handelsartikel nach ihrem Werte nebst den Konsular-Vertretungen des Deutschen Reichs und Österreich-Ungarns.

Herausgegeben mit Unterstützung des k. k. österr. Handelsmuseums in Wien. Vienna: G. Freytag & Berndt. *Price* 6 *m.* 50 *pf.*

A most instructive little general commercial atlas, showing by means of maps and diagrams the imports and exports of all important trade articles, together with their value, as well as the places where German and Austro-Hungarian consuls and vice-consuls are located in various parts of the world. The map of each country dealt with occupies the centre of the sheet, and around this is arranged a series of diagrams, showing by means of various colours and figures the value and relative importance of the exports and imports, based upon the returns for 1898. By means of red figures similar information is given for 1894, so it is easy to see at a glance the changes that have taken place in the interval. A fairly large-scale commercial map of the world is folded at the end, showing steamer routes and other information of a practical and interesting character. There is also a page of letterpress giving the authorities consulted. The atlas is published with the support of the *k. k. österr. Handelsmuseums* of Vienna.

World. **Stieler.**

Neue, neunte Lieferungs-Ausgabe von Stieler's Hand-Atlas, 100 Karten in Kupferstich, herausgegeben von Justus Perthes' Geographischer Anstalt in Gotha. 7 Lieferung. Sheets: 60 and 63. Gotha: Justus Perthes. *Price* 60 *pf.*

The two sheets contained in this part are No. 60, Arabien, and No. 63, Vorder-Indien und Inner-Asien. Both of these are on the scale of 1:7,500,000, and the former, in addition to Arabia, contains as insets a map of Palestine on the scale of 1:1,500,000 and a plan of Jerusalem on the scale of 1:20,000. No. 63 forms the southern half of a map of India and Central Asia, of which the northern section has recently been published. Both are new maps.

CHARTS.

Liverpool Bay. **Belam and Ashton.**

Chart of Liverpool Bay. Scale 1000 yards to an inch. Surveyed by Henry Belam, Commander R.N., of the Mersey Docks and Harbour Board, and H. G. G. Ashton, Assistant Marine Surveyor, 1900 (corrections 1901). *Presented by H. G. G. Ashton, Esq.*

Since the publication of this chart last year (see *Geographical Journal*, 1901), additional survey work has been carried on in Liverpool bay, and fresh soundings taken, which have rendered it necessary to bring out a revised edition. The different issues of this chart will be interesting and instructive as showing the changes that take place in the position of the sandbanks and the depths of water, apart from their service to mariners for navigation purposes.

North Atlantic Ocean and Mediterranean. **Meteorological Office, London.**

Pilot Chart of the North Atlantic and Mediterranean for July, 1902. London: Meteorological Office. *Price* 6*d.* *Presented by the Meteorological Office, London.*

U.S. Charts. **U.S. Hydrographic Office.**

Pilot Chart of the North Atlantic Ocean for June, 1902. U.S. Hydrographic Office, Washington, D.C. *Presented by the U.S. Hydrographic Office.*

World. **U.S. Hydrographic Office.**

Tracks for full-powered steam-vessels with the shortest navigable distances in nautical miles. U.S. Hydrographic Office, Washington. Chart No. 1262. *Price* 30 *cents.*

An outline chart of the world on Mercator's projection, measuring about 24 × 44 inches, and showing in blue lines and lettering, and by an ingenious arrangement of tables, the shortest navigable tracks and distances in nautical miles between the principal ports of the world. Notwithstanding the number of lines and the great amount of information given, the chart is remarkably clear. Corrections have been made up to May 24 of the present year.

PHOTOGRAPHS.

China. **Parsons.**

Seventeen Photographs of the country between Hankau and Canton, taken by W. Barclay Parsons, Esq. *Presented by W. Barclay Parsons, Esq.*

These photographs are in continuation of those already presented by Mr. Barclay Parsons which were noticed in the *Geographical Journal* for May last. They are

enlargements, and most of them are remarkably good specimens. The following are their titles:—

(1) A sail; (2) Lo-chang in Northern Kwang-tung; (3) Rowing a junk on the Pei Ho: the oarsman next to the boat is a woman; (4) The gorge of the Wu-shui in northern Kwang-tung; (5) Ping-tisiang bridge in Western Kiang-si; (6) A fine arch; (7) Three wheels for irrigation—different sizes to elevate to different levels; (8) A highway of the first class; (9) A pontoon bridge across the Lu Ho in Central Hu-nan; (10) A farmhouse in Hu-nan; (11) The line between the provinces of Hu-nan and Hu-peh, Hu-nan across the river; a remarkable bridge of stone beams; (12) A Yang-tse gunboat; (13) An old road with a paved strip in the centre for wheelbarrows, the wheels of which have worn a grove; (14) A village street; (15) Junks at Hankau (in the distance); (16) Wu-chang pagoda; (17) The Bung at Wu-chang—Chinese design and construction.

South Australia.

Four Photographs of the Flinders Memorial on the Bluff and Mount Lofty, Encounter Bay, South Australia. *Presented by the Royal Geographical Society of Australasia (South Australian Branch).*

An interesting set of photographs representing the memorial pillar and tablet with inscription which has recently been erected upon the summit of Mount Lofty, South Australia, to commemorate the meeting of Matthew Flinders, the explorer of the South Australian coast, with the French expedition under Baudin on April 8, 1802. As will be seen by the titles, there is also one of the Bluff, Encounter Bay, near to which the actual meeting took place, and another of the tablet with the record of the event which has been placed there. These photographs are important from an historical point of view.

(1) The Bluff, Encounter bay, from Granite island; (2) Tablet on the summit of The Bluff, Encounter bay; (3) Flinders column, Mount Lofty; (4) "Tablet" on Flinders column, Mount Lofty, March 22, 1902.

West Indies. **André.**

Twenty-seven Photographs of St. Vincent and Martinique, taken before and after the eruptions by Messrs. E. André and Felix Morin. *Presented by E. André, Esq.*

Some of these photographs accompanied Mr. André's paper in the *Geographical Journal* for last month. They vary in size and merit, but are especially interesting at the present time. The following are the titles:—

(1) Map of St. Vincent; (2) Kingstown, the capital of St. Vincent; (3) Georgetown, St. Vincent, showing thick bed of volcanic dust covering the country; (4 and 5) The Dry river, just beyond Langley Park, taken some time before the eruption, St. Vincent; (6) Panorama of the same country to-day; (7) The Soufrière from Georgetown, St. Vincent covered by smoke; whole country covered with volcanic dust; (8) Crater of the Soufrière, taken some years before the eruption, St. Vincent; (9) Street in Georgetown, St. Vincent: on the right, gallery broken in by weight of dust; (10) Appearance of vegetation: the large trees are bread-fruit trees; (11) Whale which floated ashore close to Georgetown, St. Vincent, probably killed by eruption; (12) Mountains in direction of the Soufrière, St. Vincent; (13) Ruined Waterloo Works, out of which 87 bodies were taken; (14) Dragging the dead to the trenches; (15) One of the hospitals; (16) Appearance of the country after the eruption; (17) H.M.S. *Indefatigable* bringing relief from Trinidad; (18, 19, and 20) St. Pierre, Martinique, before eruption; (21, 22, and 23) St. Pierre, Martinique, after eruption; (24) Steamer *Roraima*; (25) Women of the middle class (St. Pierre, Martinique): this interesting photograph was taken some time before the eruption, and represents the people who perished in the catastrophe; (26) Ruins of Empress Josephine's birthplace; (27) Usine Guérin, the first place destroyed by the eruption.

N.B.—It would greatly add to the value of the collection of Photographs which has been established in the Map Room, if all the Fellows of the Society who have taken photographs during their travels, would forward copies of them to the Map Curator, by whom they will be acknowledged. Should the donor have purchased the photographs, it will be useful for reference if the name of the photographer and his address are given.